Understanding task-related learning: When, Why, How

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Prove all things; hold fast that which is good.

1 Thessalonians 5:21 (the Bible, King James Version)

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Chapter 1

General introduction

All the world is a laboratory to the inquiring mind
Martin H. Fischer, 1944

1.1 Introduction

It is generally accepted that individuals learn throughout their lives and that much of that learning takes place in workplace settings (Matthews & Candy, 1999), if only because many adults spend a large proportion of their lives at work. Because today's workplaces are continuously changing (e.g., by technological developments, globalized competition, reorganizations and organizational development; Brown, Green & Lauder, 2001; Sugarman, 2001), the importance of 'learning at work' is greater than ever in order to deal with these workplace changes (Kanter, 2003; cf. Paulsson, Ivergård & Hunt, 2005). The necessity to learn new skills or new tasks as an important feature of many of today's jobs is underlined by representative surveys within Europe and the United States. In a Pan-European survey, 69% of the employees indicated that their job required them to learn new things (Parent-Thirion, Fernández Macías, Hurley & Vermeylen, 2007). This percentage was even higher in a survey that was conducted among employees in the U.S. In this study, 90% of all employees mentioned that learning new things was an essential part of their job (Bond, Galinsky & Swanberg, 1998).

When employees are asked *how* they learn in the workplace when conducting their tasks, most of them would agree that they have learned the most through their experiences. They claim that they learn the most 'just by doing things', 'the workplace itself', 'other workers' and by 'observing and listening to others' (Billet, 1996). Because of this, interest in the workplace as learning environment has intensified in the past two decades (Billet, 2002). Marsick and Watkins (1990) described this kind of task-related learning (i.e., learning that occurs when 'conducting the task', without following a formal training) as *informal learning*.

1.2 What are we talking about when we talk about learning?

Many different concepts are used when referring to (task-related) learning, such as 'competence development', 'skill acquisition', 'knowledge development' and so forth. These concepts have in common that they refer to the acquisition of new knowledge or skills or to the improvement of existing knowledge and skills. *Task-related learning* thus refers to the acquisition of new knowledge or skills or to the improvement of existing knowledge and skills when conducting or learning to conduct a task. This may occur during a formal training (i.e., *formal* learning) or, as mentioned above, while 'doing the job' or when 'conducting a task' (i.e., *informal* learning, Marsick & Watkins, 1990).

It is important to note that learning is a theoretical construct, meaning that it must be separated from its observable measures. Indeed, mixing up the theoretical construct of learning and possible observable changes in behaviour as a result of learning has created confusion over the years (Weiss, 1990). Many authors claim to examine learning, while in fact learning outcomes (such as improved performance) are measured. We attempt to eliminate this confusion by separating learning *processes* from learning *outcomes*. This distinction will be discussed further in Chapter 2.

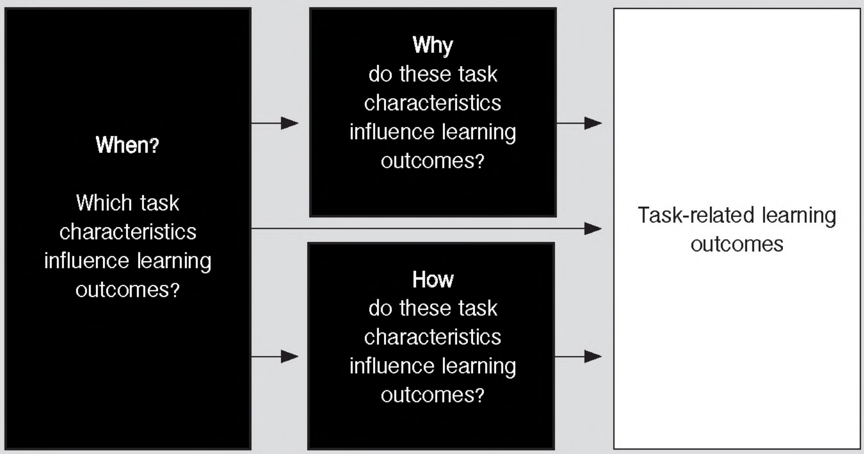
1.3 Problem statement

An important question regarding task-related learning involves how to improve task-related learning outcomes (Berings, Poell & Simons, 2005). Besides providing formal training (Tannenbaum & Yukl, 1992; Salas & Cannon-Bowers, 2001, for reviews), it is possible to create tools (like questionnaires, for the employees as well as their supervisors) to enhance awareness of learning activities and to facilitate coaching possibilities (e.g., the On-the-job-Learning-Style Questionnaire for the Nursing profession; Berings, Poell, Simons & Van Veldhoven, 2007).

Another possibility to improve task-related learning outcomes is to design the task environment in such a way that the task facilitates and stimulates (informal) task-related learning. In other words, the task characteristics may serve as antecedents of task-related learning outcomes. Interestingly enough, the improvement of task-related learning outcomes has rarely been investigated (see Chapter 2), although, as mentioned above, workers mention learning 'by doing things' and 'from the job itself' as two of the most important ways to learn at work (Billet, 1996). Considering the characteristics of a task as learning antecedents suggests that the way a particular task has been designed must be associated with the opportunities to learn when conducting the task. This assumption is grounded in several theoretical approaches, assuming that task characteristics that are incorporated in a job design would influence task-related learning outcomes (see below). This suggests that job or task (re)design is a promising possibility to increase task-related learning outcomes.

The proposed relationship between task design and task-related learning outcomes constitutes the core of this thesis. This thesis aims to understand task-related learning more deeply (see Figure 1.1) by investigating which (task-related) circumstances are beneficial (or disadvantageous) for task-related learning (i.e., *when* does task-related learning occur?). Furthermore, the thesis attempts to open the black box that connects task characteristics and task-related learning outcomes. Stated differently, we aim to examine the psychological processes that may explain *why* and *how* the assumed relationship may exist. As learning typically takes place in work situations that have not primarily been designed to foster learning, it is a practically important as well as a theoretically interesting question what task-related characteristics promote or impede the acquisition and development of knowledge or skills.

Figure 1.1: Visualization of the aim of this thesis: Understanding task-related learning



1.4 Task characteristics and task-related learning outcomes

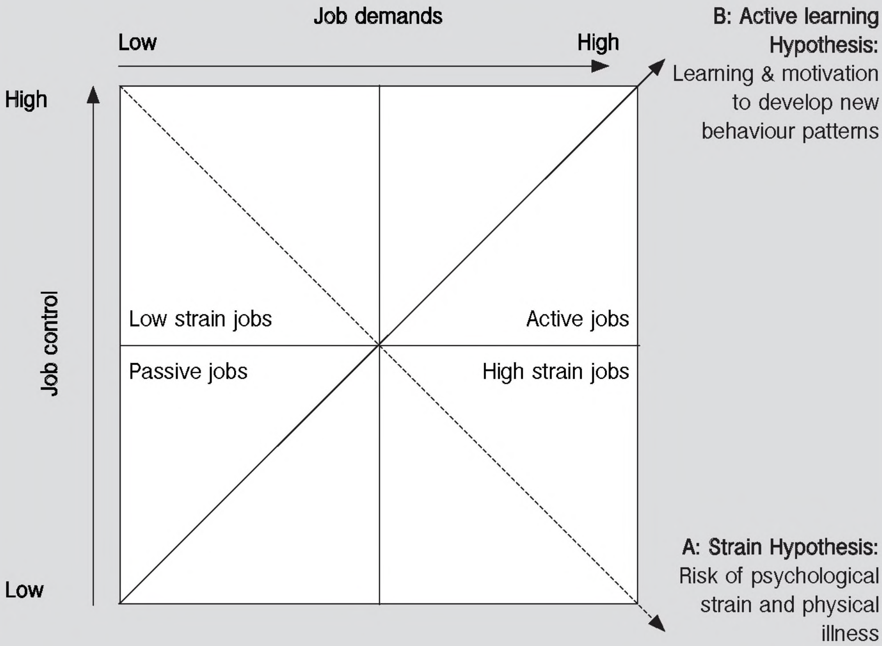
The Demand-Control model

At the heart of this thesis lies the assumption that there is a connection between the characteristics of a task and task-related learning outcomes. Within work and organizational psychology, one of the most influential theories regarding the relationship between the job design and personal outcomes such as learning behaviour is the Demand-Control model (Karasek, 1979; Karasek & Theorell, 1990). This model proposes that a work environment can be described in terms of a combination of two dimensions: 1) the psychological job demands (i.e., psychological stressors present in the work environment, such as difficult and mentally exacting work) and 2) the degree of control workers have to meet these demands. This degree of control refers to the worker's ability to control his or her own activities and skill usage and has two components (Karasek, 1998): task authority (also called autonomy, i.e., a socially predetermined control over detailed aspects of task performance) and skill discretion (also called variety, i.e., control over the use of skills by the individual).

The Demand-Control model has two central assumptions, which are reflected in diagonals A and B in Figure 1.2. The first assumption (diagonal A) is that psychological strain (for example mental fatigue or cardiovascular complaints) is particularly caused by the combination of high psychological job demands and low control, while a job with low psychological job demands and much control is a so-called 'low strain job'. Karasek stated that such a combination can be described as an interactive effect: The effects of the job demands on health and well-being vary according to the amount of control that the job provides (De Jonge & Kompier, 1997).

The second assumption (diagonal B) is that (task-related) learning as well as motivation and development opportunities will occur in 'active jobs' if both the job demands and control are high; workers who perceive high (but not overwhelming) psychological job demands in combination with high job control (providing various opportunities to deal with these demands) will develop new behaviour patterns, which will positively influence their competence and performance. The fact that workers also possess much control means that they have relatively much freedom to use various skills. The opposite of the active job is the passive job: A situation in which both psychological job demands and job control are very low. Such a passive work situation may lead to a decrease in work activities (De Jonge & Kompier, 1997).

Figure 1.2: The Job Demand-Control model (Karasek, 1979)



The Demand-Control model has been influential due to its simplicity, its emphasis on structural characteristics of the work environment and its focus on negative as well as positive effects of work (Kompier, 2003). Especially the strain hypothesis has been examined in numerous studies and comprehensive reviews have already been published (e.g. Belkiç, Landsbergis, Schnall, & Baker, 2004; De Lange, Taris, Kompier, Houtman & Bongers, 2003; Van der Doef & Maes, 1998). Although the active learning hypothesis may have theoretical as well as practical relevance, it has been investigated less frequently than the strain hypothesis. This implies that the relationship between task characteristics and learning outcomes in general, as well as the active learning hypothesis in particular, should be studied more often (e.g., De Lange et al., 2003; Taris, Kompier, De Lange, Schaufeli, & Schreurs, 2003; Taris & Kompier, 2005).

Although the Demand-Control model has provided some insight into the question *which* task characteristics promote the acquisition of new knowledge or skills (namely a combination of job demands and job control), this model remains a black box when it comes to the intrapersonal psychological processes that link the combination of job demands and job control to learning behaviour. From both a practical as well as scientific point of view, more insight into this question would be important. Practically, a better understanding of the link between task characteristics and task-related learning outcomes may be important for job redesign, enhancing our insight into questions such as "will our personnel display a higher level of active learning behaviour if their job is redesigned to give them more control over their tasks?". Scientifically, insight into the learning processes, explaining why and how task characteristics may increase task-related learning outcomes, may enhance our understanding of the factors that promote or hinder active learning behaviour (Taris & Kompier, 2005).

Other relevant theoretical models

The Demand-Control model is not the only theoretical model proposing a relationship between task characteristics and task-related learning outcomes. Four other 'grand' theories are 1) the Job Characteristics Model (Hackman & Oldham, 1975, 1980), 2) Action Theory, (Frese & Zapf, 1994; Hacker, 1998), 3) Goal Setting Theory (Locke & Latham, 1990), and 4) Self-Determination Theory (Deci & Ryan, 1985). The comparison and evaluation of these five theories may provide a theoretical answer on the questions when, why and how task-related learning may occur. For a more detailed characterisation of each of these five theories, we refer to Chapter 2 of this thesis.

1.5 Research issues and outline of this thesis

In this thesis, we aim to address three research issues that regard the questions when, why and how task-related learning may occur. The three specific research issues are:

1. Which task characteristics and which learning processes are *theoretically* assumed to promote task-related learning outcomes?
2. Does *empirical evidence* support the theoretically assumed relationships between task characteristics, learning processes and task-related learning outcomes?
3. When, why and how can the relationship between autonomy and task-related learning outcomes exist?

With respect to these three research issues, we developed ten corresponding research questions (1a-c, 2a-d, 3a-c). An overview of these research issues, their corresponding research questions and the chapters that deal with the research issues is presented below (see Table 1.1).

Research issue 1: Which task characteristics and which learning processes are theoretically assumed to promote task-related learning outcomes?
Chapter 2 aims to investigate our first research issue, by enhancing our theoretical understanding that regard the questions which task characteristics and which learning processes may be theoretically assumed to promote task-related learning outcomes. Therefore Chapter 2 discusses, compares and integrates five major theories that may be relevant to provide insight into the task characteristics that are assumed to increase task-related learning outcomes (*when* does task-related learning occur), as well as the learning processes that account for this relationship (explaining *why* and *how* these task characteristics may influence task-related learning outcomes). These five theoretical approaches are:

1. Job Characteristics Model;
2. Demand-Control model;
3. Action Theory;
4. Goal Setting Theory;
5. Self-Determination Theory.

Basically, Chapter 2 aims to provide answers to three interrelated questions, dealing with the theoretical when, why and how questions of learning a task:

1a. *When* should learning occur (i.e., which task characteristics are theoretically presumed to affect task-related learning outcomes)?

1b. Which learning processes theoretically explain *why* these task characteristics are presumed to influence task-related learning outcomes? and

1c. Which learning processes theoretically explain *how* these task characteristics are presumed to influence task-related learning outcomes?

Chapter 2 concludes with a heuristic theoretical model that provides insight into the questions when, why and how task-related learning outcomes will occur. This model is based on the aforementioned five theoretical approaches that connect task characteristics, learning processes, and task-related learning outcomes. It constitutes the foundation for Chapter 3 to 5.

Research issue 2: Does empirical evidence support the theoretically assumed relationships between task characteristics, learning processes and task-related learning outcomes?
Having theoretical insight into the relationship between task characteristics, learning processes and task-related learning outcomes is a first step. The second step is to seek the empirical evidence. Therefore, we will continue on the first

research issue in Chapter 3 by investigating to what extent empirical evidence supports (or does not support) the theoretically assumed relationships between task characteristics, learning processes and task-related learning outcomes from Chapter 2.

In dealing with this second research issue, we aim to investigate the strength of empirical evidence for the question *when* task-related learning outcomes may occur (i.e., in case of which task characteristics). Furthermore, we intend to peek into the black box between task characteristics and task-related learning outcomes by studying the questions *why* and *how* this relationship may exist. In order to get more insight into this black box, we not only investigate the strength of evidence for the relationship between task characteristics and task-related learning outcomes in which learning processes (explaining the *why* and *how* questions) are examined as mediators. Rather, we also distinguish to what extent evidence has been found for the relationship between task characteristics and task-related learning processes on the one hand, and the relationship between learning processes and task-related learning outcomes on the other hand. To this aim we quantitatively reviewed 85 studies, published between 1969 and 2005, in order to answer four specific research questions:

2a. How strong is the evidence for the theoretically proposed relationship between task characteristics and task-related learning outcomes (answering the question *when* does learning occur)?

2b. How strong is the evidence for the theoretically proposed relationship between task characteristics and learning processes?

2c. How strong is the evidence for the theoretically proposed relationship between learning processes and task-related learning outcomes?

2d. How strong is the evidence for a 'full model' including task characteristics, learning processes as mediators (explaining why and how the relationship may exist) and task-related learning outcomes?

Research issue 3: When, why and how can the relationship between autonomy and task-related learning outcomes exist?

In Chapter 2 and 3, we investigate the relationship between task characteristics, learning processes and task-related learning outcomes broadly (taking into account a variety of theoretical approaches and a large and heterogeneous set of empirical studies). In Chapter 4 and 5 we continue our investigation to understand why and how task-related learning may occur, but in these two chapters we focus on one of the assumed relationships, namely the relationship between autonomy[1] (i.e., the extent to which workers can schedule their work, make decisions and select the methods used to perform tasks; Hackman & Oldham, 1975) and task-related learning outcomes. In these chapters we aim to investigate when, why and how the relationship between autonomy and task-related learning outcomes can exist.

One of the reasons why we focus on this particular relationship is to answer one of the questions that arose from the Chapter 3 literature review regarding the relationship between autonomy and task-related learning outcomes. Our own review of the literature (Chapter 3), as well as other literature reviews (Spector, 1986; Steward, 2006) found inconclusive evidence regarding the relationship between autonomy and learning outcomes. As will be elaborated upon later in this thesis, an explanation for these results may be that the relationship between autonomy and learning outcomes is curvilinear (Warr, 2007). On the one hand, *lack* of autonomy when learning a task may be harmful for learning outcomes, because learners do not have the opportunity to explore and learn new things. On the other hand, one can also have *too much* autonomy when learning a task. This assumption thus proposes that *when* a task should be learned in case of too much autonomy provided, adverse learning outcomes will occur. In Chapter 4, we aim to investigate this assumption of a curvilinear relationship, examining the research question:

3a. Is the relationship between autonomy and task-related learning outcomes curvilinear?

In Chapter 5, we extend this study into our third research issue by examining:

3b. Why is the relationship between autonomy and task-related learning outcomes curvilinear instead of linear?

In order to examine this research question, we investigate our curvilinear hypothesis assuming that different levels of autonomy may appeal to different levels of information processing capacities. Basically, our point of departure is that learning a new task when having 'full' autonomy (and consequently no guidance) will require more expenditure of cognitive resources than learning the same task under conditions of moderate autonomy. Furthermore, in Chapter 4, we aim to investigate:

3c. Which learning processes (explaining why and how the relationship may exist) account for the relationship between autonomy and task-related learning outcomes?

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[1] This term is similar to the term 'task authority' (an important element of control) from the Demand-Control model (Karasek, 1979).

General discussion

Chapter 6 summarizes the results obtained in Chapter 2 to 5 and accordingly tries to answer our research questions. Furthermore, this chapter concentrates on the theoretical implications of our findings and it addresses the particular limitations as well as specific assets of this thesis. In this final chapter, we also formulate recommendations for future research and practical implications of our findings.

Table 1.1: Outline of thesis, including research issues, research questions deduced from these research issues and chapters providing answers to these questions

Research Issues	Research questions	Results in
1 Which task characteristics and which learning processes are theoretically assumed to increase task-related learning outcomes?	1a *When* should learning occur (i.e., which task characteristics are theoretically presumed to affect task-related learning outcomes)? 1b Which learning processes theoretically explain *why* these task characteristics are presumed to influence task-related learning outcomes? 1c Which learning processes theoretically explain *how* these task characteristics are presumed to influence task-related learning outcomes?	Chapter 2
2 Does empirical evidence support the theoretically assumed relationships between task characteristics, learning processes and task-related learning outcomes?	2a How strong is the evidence for the theoretically proposed relationship between task characteristics and task-related learning outcomes? 2b How strong is the evidence for the theoretically proposed relationship between task characteristics and learning processes? 2c How strong is the evidence for the theoretically proposed relationship between learning processes and task-related learning outcomes? 2d How strong is the evidence for a 'full model' including task characteristics, learning processes as mediators (explaining why and how the relationship may exist) and task-related learning outcomes?	Chapter 3
3 When, why and how can the relationship between autonomy and task-related learning outcomes exist?	3a Is the relationship between autonomy and task-related learning outcomes curvilinear? 3b Why is the relationship between autonomy and task-related learning outcomes curvilinear instead of linear? 3c Which learning processes (explaining why and how the relationship may exist) account for the relationship between autonomy and task-related learning outcomes?	Chapter 4 Chapter 5 Chapter 4

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Chapter 2

Task-related learning: A theoretical investigation

2

This chapter is based on:

Wielenga-Meijer, E.G.A., Taris, T.W., Kompier, M.A.J., & Wigboldus, D.H.J. (2006). Understanding task-related learning: When, why, how and who? In S. McIntyre and J. Houdmont (Eds.), *Occupational Health Psychology: European perspectives on research, education and practice* (Vol. 1, pp. 59-81). Maia (POR): ISMAI publishers.

Abstract

As learning is an essential element of work, it is an important topic in work and organizational psychology. Several theories in work and organizational psychology propose that task characteristics influence learning outcomes. However, what psychological processes account for this relationship? This chapter aims to enhance understanding of the processes that connect task characteristics to learning outcomes. To this aim, five theoretical approaches have been compared namely 1) the Job Characteristics Model, 2) the Demand-Control model, 3) Action Theory, 4) Goal Setting Theory and 5) Self-Determination Theory. This review results in a comprehensive model of the linkages between task characteristics, learning processes, and learning outcomes. Our model provides answers to questions as to when, why and how learning will occur. We conclude by providing a research agenda for future research.

2.1 Introduction

Because of rapid technological developments, globalized competition, reorganizations and organizational development, skill acquisition and development are essential in today's workplace (Brown, Green & Lauder, 2001; Sugarman, 2001). Continuous learning and competence development (or 'skill acquisition', 'knowledge development', and so forth) are necessary to deal with these workplace changes (Kanter, 2003; cf. Paulsson, Ivergård & Hunt, 2005). Learning is therefore an important topic in work and organizational psychology.

In this field it is often presumed that competence development depends on environmental characteristics such as job design. However, as yet, the psychological processes that link job design to learning outcomes are still poorly specified. The purpose of this chapter is to enhance understanding of the processes that connect task characteristics to learning outcomes. To this aim, we first discuss our conceptualization of learning. We then review and compare several important theories that link task characteristics and learning, focusing on the processes that propose to account for this association. This review shows 1) *when* learning is expected to occur (i.e., which task characteristics are presumed to affect learning outcomes), 2) *why* and 3) *how* these task characteristics are presumed to influence learning outcomes[2]. Based on an integration and extension of these theories, we then present a comprehensive model of the causal linkages between task characteristics, learning processes, and learning outcomes.

2.2 What is learning?

Learning is a theoretical construct, meaning that it must be separated from its observable records. Indeed, mixing up the theoretical construct of learning and possible observable changes in behaviour as a result of learning has created confusion over the years (Weiss, 1990). Many authors claim to examine learning, while in fact learning outcomes (such as improved performance) are measured. This confusion can be eliminated by distinguishing learning *processes* from learning *outcomes*.

A learning outcome can be defined as "a relatively permanent change in knowledge or skill produced by experience" (Weiss, 1990, pp. 172-173).

[2] These three questions correspond with Research questions 1a, 1b and 1c of this thesis (Table 1.1).

Relative permanency is necessary to differentiate learning outcomes from more transient changes due to factors like fatigue. The emphasis on *knowledge* and *skill* in this definition highlights the fact that we can distinguish between learning about something, usually referred to as declarative knowledge, and learning how to do something, usually referred to as procedural knowledge (i.e., skills, Anderson, 1982, 1983; Gagné, 1984). Thus, learning outcomes may involve either an increase in knowledge or skills by the acquisition of additional (new) knowledge or skills or a change in already acquired knowledge or skills, especially when these become automatized. In automatizing skills, the regulation of behaviour is transferred to a lower cognitive level where less conscious control (i.e., attention, mental effort) and time is required for their execution (Anderson, 1982, 1983; Hacker, 1986; Frese & Zapf, 1994; Rasmussen, 1983; 1990). This type of learning outcome is concerned with improving the feasibility and efficiency of the respective behaviour (Taris & Kompier, 2005). One example of this transfer from declarative to procedural knowledge is learning to drive a car. Until one learns to drive a car well, the various operations that are part of driving behaviour all require conscious control, while the experienced driver can execute several sequential as well as parallel operations without the need for conscious involvement.

Learning (acquiring new, as well as improving existing skills) can occur during training (i.e., *formal* learning, Marsick & Watkins, 1990). However, both kinds of learning may also occur whilst 'doing the job' (i.e., *informal* or *incidental* learning, Marsick & Watkins, 1990). Because learning in explicit training settings has been examined frequently (Tannenbaum & Yukl, 1992; Salas & Cannon-Bowers, 2001, for reviews), here we focus on informal learning. As this typically takes place in work situations that have not primarily been designed to foster learning, it is a practically important as well as a theoretically interesting question what task-related characteristics promote or impede the acquisition and development of knowledge or skills. Below we discuss five theoretical approaches that are relevant to understand informal learning.

Current theories on the relationships between task characteristics, self-regulative processes and learning outcomes

Although many models in work and organizational psychology are potentially relevant for studying informal learning among workers, many of these focus on broad classes of phenomena rather than on narrowly defined behaviours. This implies that we must often specify the predictions of these models for these broad classes of phenomena to the subject that interests us, in this case, informal learning. One potentially relevant broad outcome is performance. Obviously, optimal performance is the product of many factors. To perform optimally, workers must not only possess the knowledge and skills to do their job properly, but they should also be highly motivated, not be fatigued, et cetera. Thus, although performance cannot directly be equated with learning behaviour, we believe that theories that describe relations among task characteristics and worker performance are at least partly relevant for learning behaviour. Therefore, in discussing relevant theoretical frameworks for studying learning processes, theories that address performance were included, as performance is partly an observable outcome of learning.

In the selection of theoretical approaches to review, we restricted ourselves to models that address two questions: 1) *What* are the hypothesized learning outcomes? and 2) *When* (i.e., under which task conditions) does learning occur? Furthermore, at least one out of two questions about possible processes must be addressed: 1) *Why* do these task characteristics influence learning? or 2) *How* does learning occur? These decision rules preclude several theories concerning the relations between work design and psychological well being (cf. Kompier, 2003), because these mention neither learning nor performance explicitly as a work outcome (e.g., effort-reward imbalance theory, Siegrist, 2001; the Michigan stress model, Kahn, Wolfe, Quinn, Snoek & Rosenthal, 1964; or the Vitamin Model, Warr, 1987). Further, various motivational or learning theoretical approaches are excluded because task characteristics are not mentioned explicitly (e.g., self-efficacy theory, Bandura, 1977). In addition, we focus on well-known classic approaches, rather than to include theories that are largely variations on these classic approaches (cf. Kompier, 2002).

The included theoretical approaches vary with regard to age (classic versus more recent theories) and origin (i.e., typical work and organizational psychological frameworks, versus motivationally, behaviourally and cognitively oriented theories). Below we discuss 1) the Job Characteristics Model (JCM, Hackman & Oldham, 1975; 1980), 2) Karasek's (1979) Demand-Control model (DC), 3) Action Theory (AT, Frese & Zapf, 1994; Hacker, 1986), 4) Goal Setting theory (GST, Locke & Latham, 1990) and 5) Self-Determination Theory (SDT, Deci & Ryan, 1985). These theories all presume a relationship between task characteristics and learning outcomes (or performance), and are therefore relevant to the question *when* (under what environmental circumstances) employees will learn. The JCM and DC model are classic theories connecting task characteristics and learning outcomes (or performance). These theories are commonly used in work and organizational psychology and can therefore be seen as yardsticks against which the contributions of the other three theories can be judged.

What do these latter approaches add to what is already known?

The third theory, action theory, is a behaviour-oriented approach that focuses on the cognitive regulation of work actions/goals. AT provides insight into the intrapersonal processes that link task characteristics to learning outcomes, emphasizing the role of self-regulative processes such as goal setting (Taris & Kompier, 2005). In this sense, AT helps in filling the gap between the task characteristics and its learning-related outcomes, with regard to *how* people learn.

Because motivation is essential in learning (Bandura, 1986) and is even expected to "provide the foundation for learning, skill development and behaviour change" (Ford, 1992, p.22), we also selected two motivational theories: GST and SDT (note that the JCM is also considered a motivational theory). Adding these theoretical insights might provide insight in the reasons *why* people learn.

In this chapter, each of these theories is compared in terms of their convergence and divergence as regards 1) the learning-related outcome variables, 2) the task characteristics that are presumed to result in learning (when) and the underlying psychological processes that explain the 3) why and 4) how of learning. Below we first briefly introduce all five theories. For each theory, we explain when, why and how learning occurs insofar as these aspects are mentioned (see Table 2.1 for a summary).

The Job Characteristics Model. The Job Characteristics Model (JCM) was developed by Hackman and Oldham (1975, 1980) against a background of motivational problems in industrial and other work settings (Kompier, 2003). The model describes the relations among 'core job dimensions' (i.e., task characteristics), critical psychological states and selected personal and work outcomes. *Qualified performance* is considered a learning-related outcome. The extent to which the core dimensions foster internal motivation is denoted as the job's motivating potential.

When. According to the JCM, three critical psychological states account for qualified performance, namely 1) meaningfulness of the work, 2) responsibility for the work outcomes, and 3) knowledge of the results of work. These psychological states follow from five core task characteristics (when): autonomy, feedback, skill variety, task significance and task identity. In a meta-analysis, Fried and Ferris (1987) found that feedback and task identity (the degree to which a job requires completion of a 'whole' and identifiable piece of work) had the strongest relations with performance.

Why. According to Hackman and Oldham (1980), autonomy fosters workers' feelings of personal responsibility for the work outcomes. Autonomy thus encourages their belief that they are personally accountable for their work outcomes. Employees are therefore stimulated to learn in order to improve their performance. Task identity, task significance and skill variety should affect the meaningfulness of work and provide incentives to learn, in order to provide more qualified performance. Hackman and Oldham's hypotheses have partly been supported. Empirical evidence revealed a relationship between these task characteristics and the corresponding critical psychological states (Renn & Vandenberg, 1995), but no significant relation was found between these states and job performance (Fried & Ferris, 1987). The latter results might suggest that learning is not influenced by these psychological states either.

Alternatively, the quality of performance may improve as function of the increasing motivating potential, since a job design with high motivating potential may evoke positive affect in employees when they perform well (Hackman & Oldham, 1980, pp. 91-92). This is in line with Langfred and Moye (2004), who assume that task autonomy will influence performance through its effect on intrinsic motivation. So, a possible mediating process between these task characteristics and learning outcomes, is intrinsic motivation. These task characteristics enhance intrinsic motivation. Therefore, motivation to learn will increase and, as a result, performance will improve.

How. Without knowledge of results, learning is impossible (Bandura, 1997, Frese & Zapf, 1994; Karasek & Theorell, 1990). Learning is affected directly by the amount of feedback one receives from the job (Hackman & Oldham, 1980). Job feedback enables employees to adjust their knowledge and skills and facilitates learning.

The Demand-Control model. The JCM focuses on autonomy and feedback, but the model does not include job demands. Karasek (1979) suggested that besides autonomy, the amount of job demands is one of the important elements that should be distinguished for a proper analysis of the job design. Karasek's Demand-Control (DC) model (1979, 1998; Karasek & Theorell, 1990) is currently the most influential stress model in occupational health psychology (Kompier, 2003). Karasek (1979) argues that a work environment can be described by two dimensions, 1) the psychological demands of the work situation and 2) the amount of decision latitude (defined as a combination of task authority and skill discretion), permitting the worker to decide how to meet these demands. The match of both dimensions will lead to *active learning behaviour*, i.e., finding new solutions for problems as well as routinization of existing skills (Taris & Kompier, 2005)

When. According to Karasek (1998), learning will occur "when control on the job is high, and psychological demands are also high, but not overwhelming" (p.34.7).

Why. Workers with high decision latitude will be able to deal effectively with high demands, thus protecting themselves from excessive strain. In such situations, new skills and the motivation to tackle new challenges develop apace (Karasek & Theorell, 1990, p.171). Learning and feelings of mastery will result.

How. Learning in high demands/high control jobs takes place by exploration behaviour. If the psychological demands are high, the employee must put considerable effort in the task. Since the decision latitude is also high, employees have room to explore different strategies to see what strategy fits the job demands best. Through this exploration behaviour, new strategies can be developed and old strategies can be improved.

According to the DC model, the combination of having high psychological job demands and high decision latitude results in more learning through exploration behaviour. Taris and Kompier (2005) concluded that the few studies addressing this issue tended to support these predictions. However, methodological and conceptual shortcomings necessitate further study. Further, they argued that the DC model is essentially a black box concerning the cognitive and self-regulative processes that account for the relationship between task characteristics and learning outcomes. We thus need other theories to open up this black box. In AT, such potentially self-regulation processes are described.

The Action-Theoretical approach. Action Theory (AT, Hacker, 1986; 1998; Frese & Zapf, 1994) is a behaviour-oriented cognitive approach, assuming that the essence of work is goal-directed behaviour. The ultimate purpose of the work is to produce a product or service (Kompier, 2003). This purpose can be achieved by following the feedback cycle (Volpert, 1971), consisting of the phases of goal setting, plan development, plan decision making, executing, monitoring, and feedback.

When. According to the AT, three task characteristics are important in learning: 1) regulation requirements (task complexity), 2) regulation possibilities (control), and 3) learning-facilitating aspects (feedback). If one's ability is sufficient, acquisition of new skills will occur when regulation possibilities match regulation requirements.

2

Why. Complexity may stimulate learning as long as the task offers workers sufficient opportunities to regulate their actions. A match between regulation requirements and regulation opportunities can lead to completeness of action, meaning that 1) the job provides opportunities to the worker to carry out all steps in the feedback cycle, and 2) that various levels of regulation can be used. These regulation levels vary in the degree to which cognitive control is required. On the lowest regulation level (the sensomotoric level), information is processed in an unconscious, automatic, parallel, rapid and effortless way. On the highest levels (the intellectual and the heuristic regulation level), information processing requires much conscious effort, is slow, involves abstract reasoning, and cannot be done in conjunction with other tasks. Carrying out all steps in the feedback cycles can lead to learning because individuals with good meta-cognitive skills (i.e., planning, monitoring and revising, Brown, Bransford, Ferara & Campione, 1983), are expected to monitor their progress, determine when they are having problems, and adjust their learning accordingly (Ford, Smith, Weissbein, Gully & Salas, 1998).

How. The AT distinguishes three processes that explain how learning may occur. First, AT focuses on the role of self-regulatory processes in learning: goal setting, plan development, plan decision making, executing, monitoring, and feedback. Setting oneself new and challenging goals may imply that one must acquire new skills to achieve that particular goal. Feedback is of particular importance here.

Another important aspect in learning is the accessibility of a good operative image system (i.e., the sum of long-term representations of condition-action-result interactions, Hacker, 1986). A good operative image system will lead to better performance, because it affects the efficiency of actions (Frese & Zapf, 1994). For example, when an employee has knowledge about relations between his actions and the output of a new software program, his exploration attempts will not merely be a case of trial and error. Rather, he might form hypotheses that will result in more efficient and effective exploration behaviour and, thus, higher levels of learning.

Finally, the usage of all regulation levels (i.e., completeness of hierarchy) might result in learning. Two types of learning can be distinguished in AT. First, finding solutions for new problems requires controlled information processing which occurs at the higher regulation levels (i.e., the heuristic and the intellectual regulation level). Second, once such a program has been developed, the actions required for executing these goals are transferred to the lower regulation levels. Skills are thus automatized. This distinction roughly matches the division between the acquisition of new skills versus the improvement of existing skills, we made earlier in this chapter.

In AT, goal setting is an important element of the learning process. However, goal setting is only one element in the feedback cycle. Furthermore, AT does not primarily focus on the conditions *when* goal setting might be most successful. Therefore, we now discuss the Goal Setting Theory below, which focuses on goals.

Goal Setting Theory. Goal Setting Theory (GST, Locke & Latham, 1990; 2002) has emerged as a leading theory in the field of work motivation. GST not only involves the concept of motivation, it also includes the learning outcome 'performance'. During the 'performance cycle', the motivation to set higher goals will increase and performance will improve (Locke & Latham, 1994). Therefore, GST is an appropriate theory to learn more about the relationship between task characteristics and learning through goal setting processes.

When. GST proposes that striving towards difficult, specific goals leads to better performance and higher motivation (compared to striving towards easy, non-specific 'do-your-best' goals). Also important for goals to be effective is that people need feedback that reveals their progress in relation to their goals. Consistent with these assumptions, Locke and Latham (1990) found that relatively difficult and specific goals produced the highest levels of effort and performance.

Why. According to Locke and Latham (1990, 1994, 2002), goals affect performance (or learning outcomes) through four processes. Firstly, goals direct attention and effort towards goal-relevant activities and away from goal-irrelevant activities. This effect occurs both cognitively and behaviourally, and is stronger when goals are specific. Secondly, goals have an energizing function. Difficult goals lead to greater effort expenditure than easy goals. Thirdly, goals affect persistence. When participants are allowed to control the time they spend on a task, difficult goals lead to prolonged effort expenditure (LaPorte & Nath, 1976). Fourthly, goals affect action indirectly by leading to arousal, discovery or usage of task-relevant knowledge and strategies (Locke & Latham, 1994, 2002). These four mechanisms mesh well with Mitchell's (1997, p. 60) definition of motivation as "those psychological processes involved with arousal, direction, intensity and persistence of voluntary actions that are goal directed". However, it should be noted that goals themselves are not motivational. Rather, it is the discrepancy between the goal and the actual performance that creates self-dissatisfaction, which serves as an incentive. People are stimulated to learn in order to reduce the discrepancy and to produce a positive self-evaluation based on an internal comparison process (Earley & Lituchy, 1991). This also clarifies why feedback is an essential aspect within the GST. Knowledge of the results is needed to note this discrepancy.

Thus, GST proposes that specific and difficult goals are motivating and therefore promote learning. This will lead to higher satisfaction and enhanced motivation to set more challenging goals. Throughout this performance cycle, goals will be adjusted; skills, ability and knowledge will improve further during successfully repeated cycles. These motivational factors are also important in Self-Determination Theory.

Self-Determination Theory. Self-Determination Theory (SDT, e.g., Deci, 1975; Deci & Ryan, 1985, 1987, 1991; Ryan & Deci, 2000) proposes that human beings have basic psychological needs for autonomy, competence and relatedness. Contexts that support the satisfaction of these needs will promote a person's autonomous self-regulation of behaviour. People are more likely to be intrinsically motivated, that is, to do an activity for the enjoyment they derive from it, when they can freely choose to pursue the activity (autonomy), master the activity (competence), and feel connected to and supported by important people, such as their manager, parents, teachers, or team-mates (relatedness) (Gagné, 2003).

SDT proposes a taxonomy of motivation types and accompanying regulation types that differ in the degree to which they represent autonomy. At one end of the continuum is amotivation, the state of lacking the intention to act. When people are amotivated, they either act passively or not at all. At the other end of the continuum is intrinsic motivation, the state of doing an activity out of interest and inherent satisfaction, which is the prototype of intrinsically regulated autonomous or self-determined behaviour. Extrinsically motivated behaviours are in between amotivation and intrinsic motivation (Ryan & Deci, 2004). Within extrinsic motivation, four types of regulation are distinguished that differ in the degree to which motivation is controlled or autonomous, and to which goals are initiated by contingencies external or internal to the person. For example, imagine an undedicated nurse who experiences controlled motivation. Her behaviour would be regulated extrinsically; she does the job just because of external contingencies (e.g., salary). On the other hand, a nurse with autonomous motivated behaviour identifies the importance of the activities for maintaining comfort and health of her patients. This nurse will be more motivated to develop her competence in order to accomplish these goals. According to the SDT, autonomous or intrinsic motivation (compared to controlled motivation) is most beneficial for learning, since these kinds of motivation involve that people engage in an activity because they find it interesting (Gagné & Deci, 2005).

When. Several contextual factors may facilitate intrinsic motivation. First, providing a rationale (i.e., a meaningful personal target) will lead to autonomous behaviour. A rationale can aid a person in understanding why self-regulation of the activity would have personal utility (Deci, Eghrari, Patrick & Leone, 1994). For example when an employee dislikes learning to master yet another new software program, but understands that working will be much more efficient or pleasant when he or she uses the program correctly. Second, meaningful positive feedback may facilitate autonomous motivation (Gagné & Deci, 2005), since this type of feedback can result in positive affect, thus stimulating to learn more in order to receive more positive feedback. A third important aspect is whether the social environment is autonomy supportive, controlling or amotivating. An autonomy supportive environment (where salience of external incentives and threats are minimized and where controlling language is avoided) has been shown to enhance autonomous motivation and to facilitate learning (Black & Deci, 2000; Deci et al., 1994; Gagné & Deci, 2005; Vansteenkiste, Simons, Lens, Sheldon & Deci, 2004).

Why. Laboratory experiments as well as field studies have shown that autonomous motivation is associated with more effective performance on relatively complex tasks (Gagné & Deci, 2005). Environmental circumstances can lead to better performance and stimulate learning since this relationship is mediated by autonomous motivation (Vansteenkiste et al., 2004).

2.3 Discussion

Comparing five theoretical approaches: What do we know?

The five theoretical frames mentioned above can be combined into a tentative model including 1) learning antecedents, 2) learning processes and 3) learning outcomes (Figure 2.1). In order to generate more insight into the relationship between task characteristics and learning we discuss these four boxes in more detail below, leading to the heuristic model presented in Figure 2.2 (this figure is identical to Figure 3.1 and 6.2).

Figure 2.1: General summary of five theoretical approaches

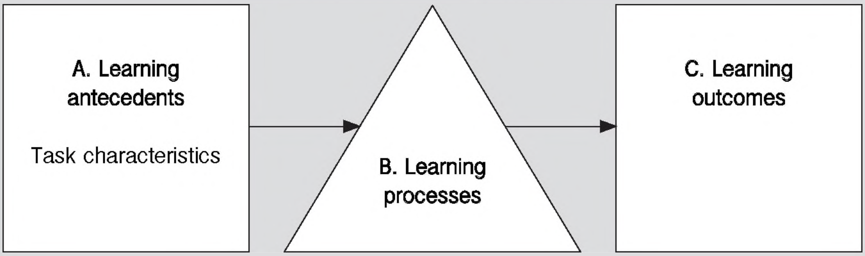
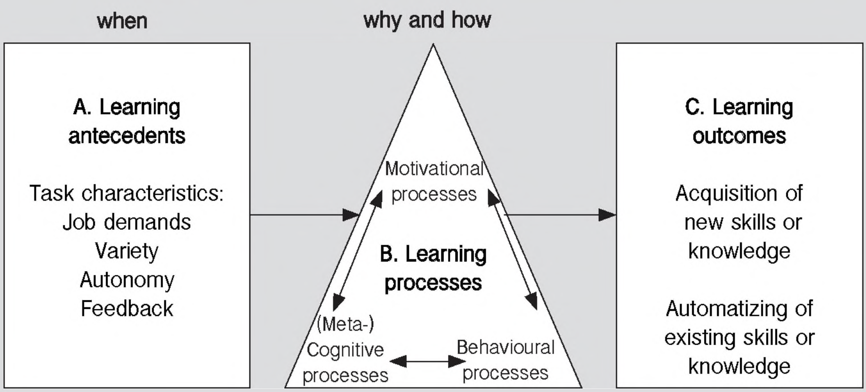


Figure 2.2: A heuristic model for learning antecedents, learning processes and learning outcomes



Learning outcomes. Although various learning outcomes were mentioned across all five theoretical approaches (e.g., active learning, qualified performance), in all theories these outcomes refer to two types of learning: 1) acquisition of new knowledge or skills and 2) improvement of existing skills (see Table 2.1). With regard to this aspect, all theories fit with our definition of learning outcomes presented in the beginning of this chapter.

Table 2.1: Comparison of five theories for the link between task characteristics and learning outcomes

	Job Characteristics Model	Demand-Control model	Action Theory	Goal Setting Theory	Self Determination Theory
What learning-related outcomes are considered?	More qualified performance: Because skills or knowledge has been acquired and/or developed	Active learning behaviour: -Finding new solutions for problems -Routinization of existing skills	Personality enhancement: -Development of new action programs -Routinization of action programs	Improving performance: Motivation to set higher goals (for which new skills or knowledge must be acquired or existing skills must be improved)	Improving performance: Performance becomes more creative (by acquiring new skills or knowledge) and more complex (by improving skills or knowledge)
When: under which (combination of) task characteristics will learning occur? (Research question 1a of this thesis)	Autonomy (A) Feedback (FB) Skill Variety (V) Task identity Task significance	Psychological demands (JD) Task authority (A) Skill discretion (V)	Regulation requirements (JD) Regulation possibilities (A) Feedback (FB) Completeness of action (V)	Goal difficulty (JD) Goal specificity (A) Feedback (FB)	Feedback (FB) Autonomy supportive environment (A)

Table 2.1: Continued

	Job Characteristics Model	Demand-Control model
Why do these task characteristics influence learning? (Research question 1b of this thesis)	Jobs with a high motivating potential affect intrinsic motivation	Workers with high decision latitude will be able to deal effectively with high demands
How do these task characteristics influence learning outcomes? (Research question 1c of this thesis)	Knowledge of the results may help adjusting knowledge or skills	The combination high demands/high control elicits learning outcomes through exploration behaviour

Note: - = not considered in theory; A = Autonomy; FB = Feedback; V = Variety; JD = Job demands

Action Theory	Goal Setting Theory	Self Determination Theory
Workers with high regulation opportunities can regulate their actions, which is conductive to learning outcomes	Specific difficult goals direct, energize and affect persistence	Autonomous motivation mediates between an automotive supportive climate and learning outcomes
Self-regulation processes (Goal setting, development of action plans, monitoring, executing, adjusting the cycles after feedback) Development and adjustment of an Operative image system affects learning outcomes Learning begins in the high regulation levels. Practicing might result in transfer of the skills to a lower regulation level	-	-

Learning antecedents. As regards the learning antecedents, each theory mentions different, albeit partly overlapping concepts. In order to compare the task characteristics mentioned in each theory, these were classified into four main clusters (Table 2.1). We have focused on the task characteristics that are mentioned in at least three of the five theoretical approaches.

High, but not overwhelming *job demands* (also referred to as workload, regulation requirements, and goal difficulty) will positively influence learning outcomes, especially through increasing intrinsic motivation. Moreover, when tasks are demanding or goals are difficult, the possible discrepancy between the desired state (i.e., the demands or goal) and one's actual competence may require learning to close this gap.

Task or skill variety plays a role in improved learning outcomes. Variety can make a task more challenging and less boring, and could therefore influence intrinsic motivation. Furthermore, variety contributes to internal recovery (Taris et al., 2006).

The importance of *autonomy* is acknowledged in four theories, proposing that the presence of autonomy (also called task authority, regulation possibilities or autonomy supportive environment) will lead to more learning.

Furthermore, *feedback* is considered an important predictor of learning. Feedback has a cognitive function, providing information as to decide whether it is necessary to adjust one's goals, planned actions and exploration behaviour. Feedback also has a motivational, behaviour-directing function.

In sum, we assume that learning occurs *when* the job provides high (but not overwhelming) job demands, variety, high autonomy and meaningful feedback. We hypothesize that these task characteristics will influence learning outcomes by means of (at least) four psychological processes: motivational, (meta-) cognitive and behavioural processes.

Learning processes. Three theories consider *intrinsic motivation* an important mediator of the relationship between task characteristics and learning outcomes. According to Ryan and Deci (2000), maintenance and enhancement of this motivational propensity requires some supportive conditions (such as high autonomy, high job demands, meaningful feedback and variety).

According to AT, the availability of a good *operative image system* (OIS) enhances the likelihood that workers will learn during their work (Frese & Zapf, 1994). The concept OIS overlaps with the better-known concept of the *mental model*, since both concepts involve internal representations of external phenomena (compare Frese & Zapf, 1994, and Proctor & Dutta, 1995) and because both include knowledge about goals, plans and feedback (compare Frese & Zapf, 1994, and Van der Veer, 1991). We prefer to use the term mental model over the term OIS, because the first is more common. We thus define a mental model as an internal representation of an external system; this external system is a network of (at least two) associated variables (cf. Brewer, 2003, p. 5; Caroll & Olson, 1988, p.51).

When employees acquire new skills, knowledge or strategies, behaviour regulation will occur at the highest regulation levels (Frese & Zapf, 1994). According to Rasmussen (1983, 1990; Vicente, 1999), reasoning in the highest regulation levels involves an explicit internal structure in the form of a mental model. For example, when learning to drive a car, an explicit internal structure guides the driver to act correctly (e.g., when I want to shift gear, I must push the clutch first). This internal structure is the cognitive basis for action regulation and comprises knowledge that enables a person to act (Frese & Zapf, 1994). When task demands are high and regulation at the two highest levels is necessary, employees must construct and develop a mental model by synthesizing the necessary knowledge or skills.

This implies that the internal representation of the external system becomes more valid and complete, which is another way of saying that the employee is 'learning'. Autonomy and feedback are relevant factors in this process as well. Jobs that provide relatively high autonomy offer better opportunities to build a mental model.

Not only cognitive processes may mediate between learning antecedents and learning outcomes, *meta-cognitive processes* (i.e., self-regulation including *goal setting*) may also mediate this relationship. Self-selected as well as assigned goals play an essential role in learning, since goals influence the self-referent thinking processes or self-regulatory processes (Cervone, Jiwani & Wood, 1991). Based on the theories we reviewed, we propose that high demands, high autonomy and meaningful feedback will affect meta-cognitive processes. High demands will lead workers to set themselves high goals. High levels of autonomy may provide opportunities to accomplish a high goal. Finally, the receipt of meaningful feedback directs the goal setting process, guides the monitoring and execution of activities, and motivates workers to pursue their goals. In sum, we propose, that high demands, high autonomy and meaningful feedback will stimulate usage of meta-cognitive processes.

Behavioural processes may also mediate the relationship between task characteristics and learning outcomes. One important type of behaviour that is instrumental to learning outcomes is *exploration behaviour*, including activities such as searching, risk taking, experimentation, playing, discovering, varying and innovating (March, 1991). According to Karasek (1979), the combination of high task demands and high autonomy provides opportunities and stimulates employees to explore.

Learning processes: Reciprocal effects. We have discussed four learning processes that can explain why and how task characteristics influence learning outcomes. However, we do not only propose that these four processes mediate the relationship between task characteristics and learning outcomes: We also suggest that these learning processes influence each other mutually. For example, picture an employee who wants to master the software program PowerPoint. Because of an initial mental model (based on experience with other software programs), his or her exploration behaviour will not be random. Rather, during this exploration, he or she is testing specific hypotheses: "if this program works similar to program Y, pushing button X should result in Z". Through feedback concerning the results of one's actions during these exploration attempts, the employee will fine-tune his or her mental model of the program when necessary ("pushing button X did not result in Z -- is this program perhaps more like program W?"). Throughout this learning process, the performer may be stimulated to set more difficult goals. Furthermore, having a better understanding of how things work may lead to positive affect and to more intrinsic motivation. Thus, we propose that these motivational, behavioural and (meta-) cognitive processes affect each other reciprocally.

Extension: Unconscious goals

Both AT and GST consider goals as *explicitly* chosen or assigned aspirations. However, a goal can also play an essential role in the psychological situation without being clearly present in consciousness (Lewin, 1936, p.19). Locke and Latham (2002) acknowledged that people can act without being fully aware of it. Hence, Locke and Latham (2002, 2004) noted that the lack of attention to the subconscious is a limitation of the Goal Setting Theory, concluding that research is needed on the effect of the subconscious on goals and on the ways in which goals arouse and affect subconscious knowledge.

The concept of unconsciousness has frequently been investigated in social cognitive theorizing and research, for example, in social-cognitive processes like person perception and stereotyping (e.g., Higgins, 1996). Since these processes can be activated unconsciously, Bargh (1990; Bargh, Gollwitzer, Lee-Chai, Barndollar & Troetschel, 2001) reasoned that goals might be triggered unconsciously as well. According to Bargh's (1990) auto-motive (AM) model, implicit goals can be activated or triggered by *environmental stimuli*. Based on the AM model, Custers and Aarts (2005) state that goals can be activated unconsciously if 1) the goal state is mentally accessible (meaning that it pre-exists in memory), 2) there is a discrepancy between the goal state and the state one is currently in, and 3) this goal state is associated with positive affect. When a goal is activated by the environment, the goal becomes operative and guides cognitive and behavioural processes within that environment, all without any conscious decision making or awareness. A recent study by Stajkovic, Locke and Blair (2006) combined a work and organizational psychological perspective with these social-cognitive insights, examining the role of subconscious goals in relation to conscious goals in the realm of performance related tasks. They found that both types of goals affected task performance, both as main effects and in interaction with each other.

In discussing the importance of goals in informal learning, we thus note that these goals can probably be activated consciously as well as unconsciously. For example, the goal 'learn to use the software program PowerPoint' can be activated because one's supervisor assigned this goal, because the employee chooses this goal, or because this goal pre-existed in memory, and is activated by looking at an impressive PowerPoint presentation of a colleague. After this presentation, the employee may begin to explore within the program without being aware this goal had just been activated.

In social cognitive research, the interest in how unconscious goals influence behaviour, cognitions and motivation is currently increasing rapidly. Although work and organizational psychology certainly recognizes the importance of *conscious goals* for learning, the potential relevance of *unconscious goals* has as yet received less attention. However, especially in a work environment much implicit learning may occur via unconsciously activated goals such as wanting to outperform a colleague or to impress a boss. In our model, we account for this notion by recognizing that goals affect learning, irrespective of whether these goals are chosen, assigned or unconsciously activated.

Heuristic model and research agenda

The combination of the notions discussed above results in the heuristic model presented in Figure 2.2. This model can be summarized in three basic propositions that are based on the ideas discussed earlier in this chapter. We also added a fourth proposition, concerning conscious and unconscious goals. Based on these propositions, an agenda for future research on the relationship between task characteristics and employee learning can be compiled. Since we are especially interested in the direction of particular relationships, future studies in this field should preferably use longitudinal or controlled laboratory designs in examining these propositions. The first proposition is that

1. *high levels of task demands, variety, autonomy and meaningful feedback facilitate the acquisition of new knowledge and skills. These task characteristics also enable the routinization of existing knowledge and skills.*

Previous -predominantly cross-sectional- research has quite convincingly shown that such a relationship exists, at least for autonomy and, to a lesser degree, for job demands (Taris & Kompier, 2005). At this moment, it would seem important to investigate the associations between these four task characteristics (job demands, variety, autonomy and feedback) and learning outcomes, separately as well as in combination with each other, in order to investigate main as well as interaction effects. Obviously, it is important to use valid manipulations or measurements of the independent (job demands, variety, autonomy, feedback) and dependent (two types of learning) concepts. The first type of learning (acquiring new skills/knowledge) could be measured by repeating performance tests, in order to assess improvement in ability or declarative knowledge.

The second type of learning (automatizing existing skills or knowledge) could be measured for example my means of reaction time measurements, by physiological data to indicate mental effort (e.g., pupillary response (Backs & Walrath, 1992), ECG, EEG (Fairclough, Venables & Tattersall, 2005)), or by a second-task paradigm (Proctor & Dutta, 1995, p. 149-152).

2. *The effect of task characteristics on learning outcomes can be explained by (motivating, (meta-) cognitive and behavioural) learning processes, including intrinsic motivation, the construction of a mental model, personal goal setting and exploration behaviour.*

Up until now, it has been unclear what psychological processes might mediate the relationship between task characteristics and learning outcomes. Since our proposition is based on theoretical insights, empirical research is badly needed here. Future research should thus examine how intrinsic motivation, the presence and development of a mental model, self-regulation processes such as goal setting and exploration behaviour (either separately or in combination with each other) mediate the relationship between task characteristics and learning outcomes.

3. *Learning processes affect each other reciprocally.*

The 'learning processes triangle' presented in this chapter has not been investigated earlier. Therefore, we suggest that the relationships proposed in this triangle are tested in order to examine whether these processes affect each other. This should occur in controlled laboratory studies, were all of the hypothesized mediating processes can be manipulated separately to examine their effect on the other processes.

4. *Finally, goals mediate the relationship between task characteristics and learning outcomes, irrespective of whether these goals are consciously or unconsciously activated.*

Research, based on both AT and GST perspectives, has shown that conscious goals may influence learning outcomes. However, up until now we know little about the role of unconscious goals. Stajkovic and colleagues (2006) suggested that this may be a fruitful domain for future research, examining the role of conscious as well as unconscious goals on task performance.

We propose that similar research be conducted on learning, in order to examine and compare the effects of conscious and unconscious goals.

2.4 Conclusion

Up until now, theoretical but fragmentary knowledge exists concerning the question what psychological processes account for the relationship between task characteristics and learning outcomes. In this chapter, we have discussed and integrated previous ideas and findings, in order to answer the questions 'why' and 'how' task characteristics will influence learning outcomes. The combination of five theoretical approaches resulted in a heuristic model, proposing that motivational, behavioural, cognitive and meta-cognitive processes could provide insight in these 'how' and 'why' questions. Furthermore, we emphasized the importance of conscious as well as unconscious goals in learning. Future research should examine these notions more closely, preferably using longitudinal as well as experimental designs.

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2

Chapter 3

From task characteristics to learning: A systematic review

3

This chapter is based on:

Wielenga-Meijer, E.G.A., Taris, T.W., Kompier, M.A.J., & Wigboldus, D.H.J. (2010). From task characteristics to learning: A systematic review. *Scandinavian Journal of Psychology, 51*, 363-375.

Abstract

Although many theoretical approaches propose that task characteristics affect employee learning outcomes, the question is *why* and *how* task characteristics influence learning outcomes. The present study reviews the evidence on the relationships among learning antecedents (i.e., task characteristics: job demands, variety, autonomy and feedback), learning processes (including motivational, meta-cognitive, cognitive and behavioural processes) and learning outcomes. Building on an integrative heuristic model, we quantitatively reviewed 85 studies published between 1969 and 2005. Our analyses revealed strong evidence for a positive relationship between job demands and autonomy on the one hand and motivational and meta-cognitive learning processes on the other. Furthermore, these learning processes were positively related to learning outcomes.

3.1 Introduction

Learning, competence development and skill acquisition are essential in today's workplace (Kanter, 2003). It is often presumed that competence development and learning depend largely on the features of one's job, such as job demands, variety and autonomy (Taris & Kompier, 2005). Unfortunately, at present the findings regarding the relationship between task characteristics and learning outcomes and the psychological processes accounting for this relationship are scattered. Thus, it is not well understood why and how task characteristics influence learning outcomes (Wielenga-Meijer, Taris, Kompier & Wigboldus, 2006; Chapter 2 of this thesis). In response to this problem, the current study presents a quantitative review of the relationships among task characteristics, learning processes and learning outcomes. In this way we can obtain more insight in the strength of these relationships, and identify gaps in our knowledge of these. Below we first discuss the theoretical foundations of the relationships between task characteristics and learning outcomes, after which we review the findings of 85 empirical studies examining these relationships.

A heuristic model of task-related learning

To guide our review, we developed a heuristic model that integrates various general theoretical models for the effects of task characteristics on learning processes and learning outcomes. Theories addressing performance were also included, as performance improvement is partly an observable outcome of learning. Five important theories were incorporated, namely Hackman and Oldham's (1975, 1980) Job Characteristics Model (JCM); Karasek's (1979) Demand-Control model (DC); Action Theory (AT, Frese & Zapf, 1994; Hacker, 1998); Goal Setting Theory (GST, Locke & Latham, 1990); and Self-Determination Theory (SDT, Deci & Ryan, 1985). As these frameworks were not specifically designed to deal with the relationships among task characteristics, learning processes and learning outcomes, they were integrated into a heuristic model to present a fuller view of the relationships among the core concepts in our study.

The JCM and DC model are classic theories that link task characteristics to learning and performance. The JCM describes the relations among core job dimensions (e.g., autonomy, variety and feedback), critical psychological states and personal as well as work consequences. Qualified performance is considered a learning-related outcome. The DC model (Karasek & Theorell, 1990) argues that a work environment can be described by two dimensions, 1) the psychological demands of the job and 2) the degree of decision latitude (defined as a combination of task authority and skill discretion). According to

Karasek (1998, p. 34.7), learning and growth will occur "when control on the job is high, and psychological demands are also high but not overwhelming". Thus, the combination of high job demands with high decision latitude fosters the acquisition of knowledge and skills (Taris & Kompier, 2005).

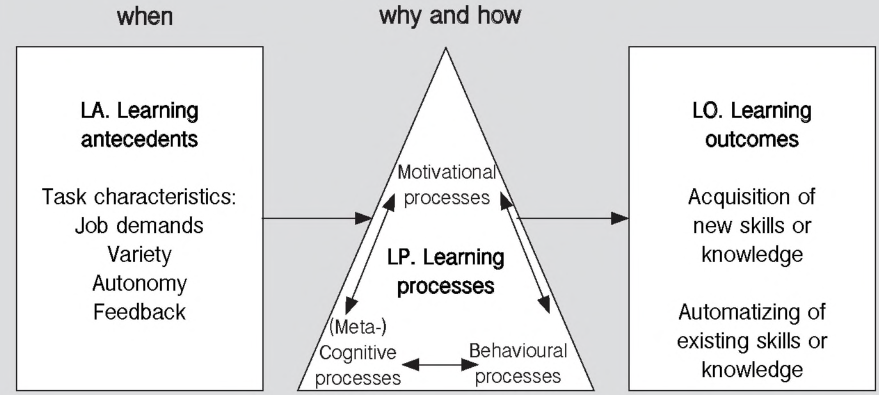
The JC and DC models suggest which task characteristics may be related to learning outcomes, but these theories provide little insight into the processes linking task characteristics to learning outcomes. German action theory (Hacker, 1998) is more useful in this respect. AT is a behaviour-oriented approach that focuses on the cognitive regulation of work actions. This theory provides insight into the intrapersonal processes that link task characteristics to learning outcomes, emphasizing the role of cognitive processes. Consequently, AT helps in filling the gap between the task characteristics and its learning-related consequences with regard to *how* people learn. Additionally, because motivation provides "the foundation for learning, skill development and behaviour change" (Ford, 1992, p.22) we also selected two motivational theories: GST and SDT (note that the JCM is also considered a motivational theory). Adding these theoretical perspectives might provide insight in the reasons *why* people learn.

The combination of these five approaches resulted in the heuristic model (Figure 3.1) that guides the current literature review. This model proposes that motivational processes provide insight in the '*why* do people learn' question, while meta-cognitive, cognitive and behavioural processes may answer the '*how* do people learn' question (Wielenga-Meijer et al., 2006). So, the relationship between task characteristics and learning outcomes might be influenced by motivational, cognitive, meta-cognitive and behavioural processes. In this review, we investigate whether these assumptions are empirically supported. For brevity, personal characteristics (such as ability and goal orientation) that may account for differences in learning behaviour were excluded. Below, we briefly discuss our model.

What is task-related learning? Learning is a theoretical construct, meaning that it must be separated from its observable records (Weiss, 1990). Many authors claim to have examined learning, where in fact only learning *outcomes* were measured. This confusion can be reduced by distinguishing learning *processes* (e.g., motivational, (meta-) cognitive and behavioural processes) from learning *outcomes*, including increased task performance. Following Weiss (1990), we define a learning outcome as "a relatively permanent change in knowledge or skill produced by experience" (pp. 172-173).

Task-related learning outcomes may thus involve both an increase in knowledge or skills by the acquisition of additional (new) knowledge or skills, or a change in previously acquired knowledge or skills.

Figure 3.1: A heuristic model for learning antecedents (LA), learning processes (LP) and learning outcomes (LO)



When does task-related learning occur? The model in Figure 3.1 (which is identical to Figure 2.2 and 6.2) includes four major task characteristics that may influence learning outcomes: job demands, variety, autonomy and feedback. Each of these characteristics is explicitly considered beneficial for learning outcomes in at least three of the five theoretical approaches mentioned above. High (but not overwhelming) *job demands* will positively influence learning outcomes (Karasek, 1998), especially through increasing intrinsic motivation. Moreover, when tasks are demanding or goals are difficult, the possible discrepancy between the desired state (i.e., the demands/goal) and one's actual competence may require learning to close this gap. *Task or skill variety* (i.e., the degree to which a job requires a variety of different activities in carrying out the work, involving the use of various skills and talents; Hackman & Oldham, 1975) will increase task challenge and could therefore affect intrinsic motivation to perform well, which will often require learning. *Autonomy* (the extent to which workers can schedule their work, make decisions, and select the methods used to perform tasks, Hackman & Oldham, 1975) should also be related to learning. The error management literature proposes that autonomy is beneficial for learning (e.g., Heimbeck, Frese, Sonnentag & Keith, 2003). However, having *too* much autonomy may impede learning (e.g., Langfred, 2004), because a worker might be overloaded with choices and coping possibilities. Finally, *feedback* (i.e., information about how far one has progressed towards the goal; Frese & Zapf, 1994) is an important predictor of learning. Feedback has a cognitive function, providing information as to decide whether it is necessary to adjust one's goals and actions. Feedback also has a motivational, behaviour-directing function.

Why and how does learning occur? We propose that these task characteristics affect learning outcomes through motivational, (meta-) cognitive as well as behavioural processes. *Intrinsic motivation* is expected to mediate the relationship between task characteristics and learning outcomes. Motivation can be defined as "the willingness to supply the effort necessary" (Ouwerkerk, Meijman & Mulder, 1994, p.22). According to Ryan and Deci (2000), maintenance and enhancement of this motivational propensity requires supportive conditions such as high job demands, variety, autonomy, and meaningful feedback.

A cognitive process that may mediate the relationship between task characteristics and learning outcomes is the construction of a *mental model* (i.e., an internal representation of an external system; cf. Brewer, 2003). When job demands are high, employees must integrate existing and new knowledge or skills to perform the task accurately. This implies that the internal representation of the external system becomes more valid and complete, i.e., the employee is 'learning'. Autonomy and feedback will affect the course of this process as well. Jobs providing much autonomy and feedback would therefore offer good opportunities to build a proper mental model (Frese & Zapf, 1994; Taris & Kompier, 2005). Furthermore, meta-cognitive processes such as *goal setting* may account for the relationship between task characteristics and learning outcomes. High demands will stimulate workers to set themselves difficult goals, whereas high levels of autonomy may provide opportunities to accomplish those goals. The receipt of meaningful feedback directs the goal setting process, guides the monitoring and execution of activities, and motivates workers to pursue their goals (e.g., Taris & Kompier, 2005).

Behavioural processes may mediate the relationship between task characteristics and learning outcomes. One important type of learning-relevant behaviour is *exploration behaviour*, including activities such as searching, risk taking, experimentation, playing, discovering, varying and innovating (March, 1991). According to Karasek (1979), the combination of high task demands and high autonomy provides opportunities and stimulates employees to explore. In turn, exploration behaviour should promote learning.

Summarizing, we propose that task characteristics (job demands, variety, autonomy and feedback) will affect learning outcomes positively. However, it can be expected that job demands and autonomy are curvilinearly related to learning, since experiencing too high (overwhelming) job demands will demotivate workers, whereas having too much autonomy will lead to ambiguity and ill-structured work processes. We assume that these effects will be mediated through motivational, (meta-)cognitive and behavioural processes. The overall purpose of this review is to map the empirical evidence currently available in a selection of journals for each of the relationships proposed in our model, examining the degree to which these relationships are supported empirically. Specifically, our research questions[3] are:

1. How strong is the evidence for the relationship between task characteristics (i.e., job demands, variety, autonomy and feedback) and learning outcomes?
2. How strong is the evidence for the relationship between task characteristics (i.e., job demands, variety, autonomy and feedback) and motivational, (meta-) cognitive, and behavioural learning processes?
3. How strong is the evidence for the relationship between motivational, (meta-) cognitive, and behavioural learning processes and learning outcomes?
4. How strong is the evidence for the full model in Figure 3.1?

3.2 Method

Identification of studies

In order to assess the evidence on the relationship between task characteristics and learning outcomes, potentially relevant studies were identified using the PsycInfo and SSCI databases. Since we aimed to provide a broad overview, we did not restrict ourselves to typical work and organization psychological journals. To make this enterprise manageable, we had to apply relatively rigid selection criteria in our search. Specifically, we confined ourselves to studies that were published before January 2006 in the English-language top-three journals (based on their 2004 SSCI impact scores) in 10 different categories that all were expected to be relevant to task-related learning (e.g., ergonomics, educational psychology, experimental psychology, applied psychology; including work and organizational psychology).

This criterion provided a selection of 23 journals across different scientific disciplines. Interestingly, although we included only high-impact journals in each category, the journals that were selected varied widely in terms of their

[3] These research questions correspond with Research questions 2a, 2b, 2c and 2d of this thesis (Table 1.1).

impact factors (ranging from 1.22 to 12.80). These differences may be due to different citation and publication practices in various fields and the number of researchers active in these areas, and do not necessarily have quality implications.

Based on the model presented in Figure 3.1, we distinguished among *learning antecedents* (LA; i.e., task characteristics), *learning processes* (LP; i.e., motivational, (meta-) cognitive and behavioural processes) and *learning outcomes* (LO; i.e., learning-related outcomes such as improved task performance). To identify as many relevant studies as possible, we used both general (e.g., 'task characteristics', 'learning processes', 'learning outcomes') as well as specific search terms (e.g., 'job demands', 'autonomy', 'motivation', 'task performance').

Inclusion criteria

Four steps were taken in identifying relevant studies. First, an automated search was conducted in the selected journals, using the sets of key words given above. Second, studies were excluded when the study focused on animals, non-adults (children, adolescents) or people with enduring mental and/or physical deficits (e.g., sicknesses, learning disabilities, brain damage), or when the topic concerned addiction (e.g., drugs or alcohol usage). Third, the abstracts of the remaining papers were reviewed independently by the first two authors. Studies were considered appropriate when 1) the study provided (original) empirical data, 2) the study investigated at least one of the relationships included in our conceptual model, 3) the task characteristics or learning processes were measured and analyzed separately, i.e., combined measures or analyses were excluded in order to identify the unique contribution of each factor, 4) the variables of interest were included as dependent, independent, mediating or moderating variables (and not just as a manipulation check or covariate) and 5) when learning outcomes were measured objectively (i.e., studies including only self-reported learning outcomes were excluded, since these studies provide little information concerning actual learning; cf. Taris, 2006). The two assessors rated each study as either 'irrelevant', 'potentially relevant' or 'undecided'. Their ratings converged on 98% of all articles. Finally, studies that were considered potentially relevant or undecided (as well as the studies on which the raters disagreed in the prior step) were retrieved and read in full by the first author. Studies were evaluated on the basis of the full manuscript using the criteria employed in the first three steps. Ratings were discussed until the raters agreed on the in- or exclusion of all studies.

Evidence synthesis

Due to the diversity of our selection of studies (in terms of their conceptualization, instruments, analyses, et cetera) it was impossible to conduct a formal meta-analysis or any other analysis that focuses on effect sizes (e.g., Hunter and Schmidt's, 2004, approach), since not all studies reported the necessary data. Discarding studies that did not provide effect sizes could lead to the exclusion of relevant and valuable studies (Slavin, 1995). In order to avoid 'vote-counting' (Van Tulder, Furland, Bombardier & Bouter, 2003) and to quantify the evidence as much as possible, we developed a *standardized index of convergence* (SIC).

SIC is defined as $SIC = \frac{n_{positive} - n_{negative}}{n_{total}}$, with $n_{positive}$ representing the number of studies examining the defined relationship that reported a significant positive relationship, $n_{negative}$ representing the number of studies that found a significant negative relationship, and n_{total} representing the total number of studies (including studies that did not find a significant association) for the defined relationship. SIC thus ranges from –1 (all available studies present significant negative relationships) to +1 (all available studies present significant positive relationships). A SIC close to zero means either that studies investigating this relationship did not find a positive or negative relationship, or that these studies reported inconsistent results (i.e., the numbers of studies reporting a positive or a negative relationship are about equal, resulting in a numerator close to zero). For convenience, we add the number of studies upon which a SIC is based to that SIC, i.e., SIC(5) means that this particular estimate is based on five studies.

In estimating the strength of the evidence for the relationships studied here, we focused on 1) the *number* of studies investigating each of the relationships, and 2) *the consistency* of the relationships (expressed by SIC), respectively. These two aspects were combined, yielding eight categories reflecting the strength of the evidence for the relationships examined here (cf. Van Tulder et al., 2003). As Table 3.1 shows, we distinguish among *strong evidence* (+++ or ---), *moderate evidence* (++ or --), *limited evidence* (+ or -), *inconsistent evidence* (0; meaning that either both negative and positive results were found, or that no significant association was reported; this will be explained when necessary); or *insufficient evidence* (i.e., if only 1 or 2 studies were conducted, or 3 or more studies that were all reported in the same paper).

Table 3.1: Strength of the evidence for the relationships studied in this review, as based on the number of studies for each relation and the corresponding SICs

# of studies	SIC				
	-1.00 to -.60	-.59 to -.30	-.29 to .29	.30 to .59	.60 to 1.00
1 - 2	insufficient evidence				
3 - 5	--	-	0	+	++
≥ 6	---	--	0	++	+++

Note: 0 = inconsistent evidence; + (-) = limited evidence for a positive (negative) relationship; ++ (--) = moderately strong evidence for a positive (negative) relationship; +++ (---) = strong evidence for a positive (negative) relationship.

3.3 Results

Table 3.2 presents the results of our search. We identified 629 articles containing at least two of the key words. After omitting the articles focusing on non-adults, people with deficits or addiction (step 2), 559 articles were withheld. After the abstracts thereof had been evaluated by the two raters (step 3), 109 potentially relevant articles remained. In the final step, where one rater (first author) read all studies in full, 62 articles (including 85 studies) remained.

Descriptive data

Table 3.3 provides an overview of the number of studies in relation to their content. The first column of this table shows that the three boxes of our heuristic model (i.e., learning antecedents, processes and outcomes) contained about equal numbers of studies. However, there were large differences within these boxes. Considering task characteristics (i.e., learning antecedents), only two studies examined variety as an independent variable. As regards learning processes, the cognitive process 'construction of a mental model' was investigated in five studies (6%), whereas motivational concepts were investigated in half of the studies (52%).

Research questions

Relationship between learning antecedents and learning outcomes. Fifty of the 85 studies investigated the relationship between learning antecedents and learning outcomes (including 18 studies in the LA-LO and 32 in the LA-LP-LO categories). Eighteen of these investigated job demands, two studies examined variety, 15 studies looked into autonomy and 23 studies focused on feedback.

Table 3.2: Number of studies per category that remained after each step

Number of remaining papers after step:	Categories				# of articles	# of studies
	LA-LP-LO	LA-LO	LP-LO	LA-LP		
1 Automatized search [1]	32	76	459	62	629	
2 Exclusion of studies focusing on animals, non-adults, deficits or addiction	28	66	406	59	559	
3 Judged as 'potentially relevant' or 'undecided' by two raters, as based on the abstract	15	14	62	18	109	
4 Judged as 'clearly relevant', as based on the whole article	10	9	32	11	62	
5 Reorganization # of articles[2]	21	17	17	11		
# of relevant studies	32	18	19	16		85

1 Automated searches were conducted in PsycInfo and Web of Science. In PsycInfo keywords were searched in the abstracts. The filters 'Adulthood' and 'Human' were used. In Web of Science, the keywords were added as 'topics' and the search was based on 'articles'.

2 Because some articles include studies for more than one category, some overlap exists.

Job demands and learning outcomes. Most of the 18 studies considering job demands employed an experimental design (*n* = 15). In the three survey studies, workload (Bakker, Demerouti & Verbeke, 2004), challenge/hindrance stress (LePine, LePine & Jackson, 2004) and lack of challenge (reversed to workload; Morrison & Brantner, 1992) were examined cross-sectionally using self-report measures.

All 15 experimental studies employed undergraduate students. Eleven of these (Audia, Kristof-Brown, Brown & Locke, 1996; Cervone, Jiwani & Wood, 1991; Earley & Lituchy, 1991, Study 1,2; Gellatly & Meyer, 1992, Study 1,2; Gendolla

& Krüsken, 2002, Study 1,2; Meyer & Gellatly, 1988, Study 1,2; Vancouver, Thompson & Williams, 2001, Study 1) were based on Goal Setting Theory (Locke & Latham, 1990) and manipulated *goal difficulty*. The designs included two to four conditions (i.e., no, easy, moderately, (extremely) difficult or impossible goals had to be achieved).

Table 3.3: Descriptive data: Overview of the global focus of all studies

	# of studies	% of all studies		# of studies	% of all studies
Learning antecedents	66	78	Job demands	23	27
			Variety	2	1
			Autonomy	20	24
			Feedback	31	36
Learning processes	67	79	Motivation	44	52
			Goal setting	21	24
			Mental Model	5	6
			Exploration behaviour	10	12
Learning outcomes	69	81			

The three survey studies examining the relationship between job demands and learning outcomes showed inconsistent findings, SIC(3) = .00. However, the evidence was clearer in the experimental studies, SIC(15) = .47 (Table 3.4). When we restricted ourselves to the 11 goal setting experiments, SIC increased to .91 (not shown), strongly supporting the hypothesis that goal difficulty is positively related to learning outcomes (cf. Table 3.1). Interestingly, two studies (Gellatly & Meyer, 1992, Study 2; Meyer & Gellatly, 1988, Study 1) found that the effects of setting an impossible goal did not differ significantly from setting a difficult goal, providing evidence for a curvilinear relationship between job demands and learning outcomes.

In conclusion, the 18 studies investigating the relationship between job demands and learning outcomes provide moderately strong evidence for a positive relationship between both concepts, SIC(18) = .39. This evidence is mainly due to the experimental studies (especially to studies manipulating goal difficulty), suggesting that our hypothesis concerning the causality of this relationship is supported as well.

Variety and learning outcomes. Despite the assumed relevance of variety for learning outcomes (e.g., Hackman & Oldham, 1980), only two studies examined this relationship. Whereas Morgeson, Delaney-Klinger and Hemingway (2005) found a positive relationship between job role breadth (i.e., variety during the job) and performance, Steers and Spencer (1977) failed to find a significant association between variety and performance.

Autonomy and learning outcomes. Five survey studies investigated the relationship between autonomy and learning outcomes (Bakker et al., 2004; Bond & Bunce, 2003; Colarelli, Dean & Konstans, 1987; Morgeson et al., 2005; Steers & Spencer, 1977), yielding a SIC(5) = .60 (Table 3.4). This provides moderately strong evidence for a positive relationship between autonomy and learning outcomes.

Ten studies employed an experimental design (Davis & Bostrom 1993; Davis & Wiedenbeck 1998, Study 1,2; Erez & Arad, 1986; Keith & Frese, 2005; Trudel & Payne 1995, Study 1,2; Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004; Zhou, 1998). The results of the these experimental studies varied strongly, leading to a SIC(10) of only .20.

In sum, the 15 studies investigating the relationship between autonomy and learning outcomes provide moderately strong evidence for a positive relationship, SIC(15) = .33. This is mainly due to the convergence of the results of the survey studies, as the results of the experimental studies were not always consistent with our expectations.

Feedback and learning outcomes. The relationship between feedback and learning outcomes was examined in 23 studies. These studies differed strongly regarding the type of feedback that was measured or manipulated, meaning that we must distinguish among the aspects of feedback that were measured or manipulated. Most studies (*n* = 13) examined *feedback sign,* i.e., (true or bogus) positive versus negative feedback (Brunstein & Maier, 2005, Study 1,2; Fazio, Eiser & Shook, 2004, Study 1-5; Kinicki et al., 2004; Parsons, Herold, & Leatherwood, 1985; Quiñones, 1995; Vancouver & Tischner, 2004; Zajonc & Brickman, 1969; Zhou, 1998). The results of these studies were inconsistent, SIC(13) = .08.

Table 3.4: Number of studies and Standardized Index of Convergence (SIC) for all relationships

Type of relationship		All studies		Survey studies and Cross-sectional studies		Experimental studies	
Learning antecedents	*Learning outcomes*	SIC		SIC		SIC	
Job demands	Learning outcomes	(11-4)/18 = .39	++	(1-1)/3 = .00	0	(10-3)/15 = .47	++
Variety		(1-0)/2 = .50	#	(1-0)/2 = .50	#		
Autonomy		(7-2)/15 = .33	++	(3-0)/5 = .60	++	(4-2)/10 = .20	0
Feedback sign		(4-5)/13 = .08	0	(1-5)/7 = .57	--	(3-0)/6 = .50	++
Feedback frequency		(3-0)/5 = 0.60	++	(1-0)/1 = 1.00	#	(2-0)/4 = .50	+
Feedback specificity		(2-0)/4 = .50	+	(1-0)/1 = 1.00	#	(1-0)/3 = .33	+
Learning antecedents	*Learning processes*	SIC		SIC		SIC	
Job demands	- Motivation - Goal setting - Mental model* - Exploration behaviour	(8-0)/11 = .73 (6-0)/9 = .67 (0-0)/2 = .00	+++ +++ #	(2-0)/3 = .67	++	(6-0)/8 = .75 (6-0)/9 = .67 (0-0)/2 = .00	+++ +++ #
Variety	- Motivation* - Goal setting* - Mental model* - Exploration behaviour*						
Autonomy	- Motivation - Goal setting - Mental model - Exploration behaviour	(6-0)/8 = .75 (1-0)/1 = 1.00 (2-0)/2 = 1.00 (2-0)/2 = 1.00	+++ # # #	(4-0)/5 = .80	++	(2-0)/3 = .67 (1-0)/1 = 1.00 (2-0)/2 = 1.00 (2-0)/2 = 1.00	++ # # #

Table 3.4: Continued

Type of relationship		All studies		Survey studies and Cross-sectional studies		Experimental studies	
Learning antecedents	*Learning processes*	SIC		SIC		SIC	
Feedback sign	- Motivation	(6-0)/9 = .67	+++	(1-0)/1 = 1.00	#	(5-0)/8 = .63	+++
	- Goal setting	(2-0)/2 = 1.00	#			(2-0)/2 = 1.00	#
	- Mental model*						
	- Exploration behaviour	(4-0)/4 = 1.00	#	(4-0)/4 = 1.00	#		
Feedback frequency	- Motivation	(2-0)/4 = .50	+	(2-0)/4 = .50	+		
	- Goal setting	(1-0)/1 = 1.00	#			(1-0)/1 = 1.00	#
	- Mental model*						
	- Exploration behaviour*						
Feedback specificity	- Motivation	(0-0)/1 = .00	#	(0-0)/1 = .00	#		
	- Goal setting*						
	- Mental model*						
	- Exploration behaviour	(0-1)/2 = -.50	#			(0-1)/2 = -.50	#
Learning processes	*Learning outcomes*	SIC		SIC		SIC	
Motivation	Learning outcomes	(19-1)/24 = .75	+++	(19-1)/24 = .75	+++		
Goal setting		(19-0)/19 = 1.00	+++	(19-0)/19 = 1.00	+++		
Mental model		(3-0)/3 = 1.00	++	(2-0)/2 = 1.00	++	(1-0)/1 = 1.00	#
Exploration		(2-0)/3 = .67	++	(2-0)/3 = .67	++		

Note: 0 = inconsistent evidence; + (-) = limited evidence for a positive (negative) relationship; ++ (--) = moderately strong evidence for a positive (negative) relationship;
+++ (---) = strong evidence for a positive (negative) relationship.
* = This relationship was not investigated in the studies included in this review.
# = Insufficient evidence, i.e., this relationship was investigated in fewer than three studies, or all studies were reported in the same paper.

Five studies investigated the relationship between feedback frequency (i.e., how often feedback is provided) and learning outcomes (Colarelli et al., 1987; DeShon, Kozlowski, Schmidt, Milner & Wiechmann, 2004; Fazio et al., 2004, Study 2; Kinicki et al., 2004; Steers & Spencer, 1977). These studies showed positive or no effects, SIC(5) = .60. The four studies investigating feedback specificity (referring to the level of information presented in feedback messages; Goodman, Wood & Hendrickx, 2004) and learning outcomes reported similar positive or neutral relationships (Goodman & Wood, 2004; Goodman et al., 2004; Kinicki et al., 2004; Shute & Gluck, 1996, SIC(4) = .50). Furthermore, two studies examined the effect of feedback content (quality versus quantity feedback; Gellatly & Meyer, 1992, Study 2; Ilgen & Moore, 1987), showing that quality feedback led to better learning outcomes than quantity feedback. Finally, one study investigated feedback style (Zhou, 1998), reporting that informational feedback resulted in better learning outcomes than controlling feedback.

In sum, the evidence for a relationship between feedback sign and learning outcomes is inconsistent. There is moderately strong evidence for a positive relationship between feedback frequency and learning outcomes, and limited evidence for a positive relationship between feedback specificity and learning outcomes.

Relationship between learning antecedents and learning processes

Job demands and learning processes. The relationship between job demands and motivation was investigated in five surveys (Griffin, 2001, Study 1,2; Lawler & Hall, 1970; LePine et al., 2004; Rasch & Tosi, 1992) and eight experimental studies (Cervone et al., 1991; Gellatly & Meyer, 1992, Study 1,2; Gendolla & Krüsken, 2002, Study 1,2; Steele-Johnson, Beauregard, Hoover, & Schmidt, 2000, Study 1,2; Wright, Contrada & Patane, 1986). The relationship with goal setting (9 studies, Audia et al., 1996; Cervone et al., 1991; Earley & Lituchy, 1991, Study 1,2; Gellatly & Meyer, 1992, Study 1,2; Meyer & Gellatly, 1988, Study 1,2; Steele-Johnson et al., 2000, Study 2) and exploration (2 studies, Audia et al., 1996; Cervone et al., 1991) was investigated experimentally only. Table 3.4 shows that there is strong evidence for positive relationships between job demands and motivation, SIC(11) = .73, and goal setting, SIC(9) = .67. When considering the relationship between job demands and motivation, two studies dealing with the effects of *excessive* job demands were excluded (Griffin, 2001, Study 1,2). These studies showed that excessive job demands were negatively related to positive affect.

Autonomy and learning processes. Eight studies investigated the relationship between autonomy and motivation (Colarelli et al., 1987; Lawler & Hall, 1970; Williams & Deci, 1996, Study 1,2; Sansone, Sachau & Weir, 1989, Study 2; Vansteenkiste et al., 2004, Study 1,2; Wright & Cordary, 1999), providing strong evidence for a positive relationship between these concepts, SIC(8) = .75. Furthermore, the relationships between autonomy and the other three hypothesized learning processes were investigated in only one or two studies. All these studies found positive effects. However, because of the small number of studies, this evidence is insufficient to report a SIC.

3

Feedback and learning processes. Feedback is the most frequently investigated task characteristic within our selection of studies. As for feedback and learning outcomes, the studies regarding the relationship between feedback and learning processes focused on very diverse kinds of feedback. The relationship between feedback and motivation was investigated most often (n = 15). Nine of these studies addressed *feedback sign* (Brunstein & Maier, 2005, Study 1,2; Ilies & Judge, 2005, Study 1,2; Kinicki et al., 2004; Quiñones, 1995; Sansone, 1986, Study 1, 2; Sansone et al., 1989, Study 1), revealing either a positive or no relationship, SIC(9) = .67. Four studies focused on the relationship between *feedback frequency* and motivation (Colarelli et al., 1987; Harackiewicz & Larson, 1986; Kinicki et al., 2004; Lawler & Hall, 1970), revealing either positive or non-significant findings, SIC(4) = .50. Furthermore, four studies (Fazio et al., 2004, Study 1,3-5) reported a positive relationship between feedback sign and exploration behaviour. Since these four studies were reported in the same paper, this evidence is insufficient to report a SIC.

Regarding the relationship between feedback and learning processes we may conclude that there is limited evidence for a positive relationship between feedback frequency and motivation. Furthermore, we found strong evidence for a positive relationship between feedback sign and motivation.

Learning processes and learning outcomes

Motivational processes and learning outcomes. Six of the 24 studies examining the relationship between motivational processes and learning outcomes employed a survey design (Barrick, Steward & Pintrnwski, 2002; Colarelli et al., 1987; Erez & Judge, 2001, Study 3; Kinicki et al., 2004; Lee, Sheldon & Turban, 2003; LePine et al., 2004). Four of these found a positive relationship between motivational processes and learning outcomes, SIC(6) = .67 (not shown). The remaining 18 studies examined this relationship cross-sectionally in experiments with undergraduates, manipulating various independent variables (e.g., task characteristics). Since the motivational processes were measured rather than manipulated, these experiments were classified as 'cross-sectional' studies. Most of these showed a positive relationship between motivational processes and learning outcomes, SIC(18) = .78 (not shown). Accordingly, the evidence for a positive relationship between motivational processes and learning outcomes is strong, overall SIC(24) = .75.

Meta-cognitive processes and learning outcomes. Nineteen studies investigated the relationship between meta-cognitive processes and learning outcomes. Four studies employed a survey design (two longitudinal studies: Earley & Lituchy, 1991, Study 3; Lee et al., 2003, and two cross-sectional studies: Erez & Judge, 2001, Study 3; Johnson, 2005). The remaining 15 studies (Audia et al., 1996; Cervone et al., 1991; DeShon et al., 2004; Earley & Lituchy, 1991, Study 1; Ford, Smith, Weissbein, Gully & Salas, 1998; Gellatly, 1996; Gellatly & Meyer, 1992, Study 1,2; Keith & Frese, 2005; Meyer & Gellatly, 1988, Study 1,2; Mitchell, Hopper, Daniels, George-Falvy, & James, 1994; Vancouver et al., 2001, Study 1,2) examined meta-cognitive processes cross-sectionally during an experiment. One of these (Keith & Frese, 2005) also manipulated meta-cognitive processes experimentally. All 19 studies showed a positive relationship between meta-cognitive processes and learning outcomes, SIC(19) = 1.00. Note that due to design limitations, it cannot be concluded that the degree to which participants engage in meta-cognitive processes is *causally* related to learning outcomes. For example, Vancouver et al. (2001) found that performance positively influenced goal setting, rather than vice versa.

Cognitive processes and learning outcomes. Three studies (Davies, 1994; Davis & Yi, 2004; Lazonder & Van der Meij, 1995) investigated the relationship between cognitive processes and learning outcomes. All studies reported a positive relationship between cognitive processes and learning outcomes, SIC(3) = 1.00, providing moderately strong evidence for a positive relationship between these concepts.

Behavioural processes and learning outcomes. Out of the three studies addressing the relationship between exploration behaviour and learning outcomes (Audia et al., 1996; Goodman et al., 2004; Shute & Gluck, 1996), two (Goodman et al., 2004; Shute & Gluck, 1996) found a positive relationship between both concepts, SIC(3) = .67. This provides moderately strong evidence for a positive relationship between exploration behaviour and learning outcomes.

Learning antecedents, learning processes and learning outcomes

Although 32 studies were categorized as 'LA-LP-LO' studies, only 11 of these investigated the relationships among learning antecedents, learning processes and learning outcomes in a full model (Brunstein & Gollwitzer, 1996, Study 1; Earley & Lituchy, 1991, Study 1,2; Goodman et al., 2004; Keith & Frese, 2005; Kinicki, 2004; LePine et al., 2004, Meyer & Gellatly, 1988, Study 1,2; Vansteenkiste et al., 2004, Study 1,2). These studies were also included in our discussions of the LA-LO, LA-LP and LP-LO relationships.

Five studies examined the relationship between job demands (goal difficulty and challenge stress) and learning outcomes (Earley & Lituchy, 1991, Study 1,2; LePine et al., 2004; Meyer & Gellatly, 1988, Study 1,2), with either having a personal goal or motivation to learn as the variable mediating this relationship. Another three studies focused on the relationship between autonomy and learning outcomes (Keith & Frese, 2005; Vansteenkiste et al., 2004, Study 1,2), with meta-cognition and motivation as intervening variables, respectively. Finally, three studies considered the relationship between feedback (sign, frequency and specificity) and learning outcomes (Brunstein & Gollwitzer, 1996, Study 1; Goodman et al., 2004; Kinicki et al., 2004), with motivation and exploration behaviour as mediating variables.

The Goodman et al. (2004) study failed to find a significant relationship between the learning antecedent (feedback specificity) and the learning consequence (learning), thus not supporting a mediational model in Baron and Kenny's (1986) terms. Three (out of four) studies investigating whether the relationship between goal difficulty and learning outcomes is mediated by personal goals, reported that setting personal goals mediated the relationship between goal difficulty and performance (Earley & Lituchy, 1991, Study 1,2; Meyer & Gellatly, 1988, Study 1). The other six studies also found that the relationship between the task characteristic under study and the learning outcome was (at least partly) mediated by the learning process under investigation. However, as these six studies examined rather different relationships (with the exception of the relationship between goal difficulty, setting a personal goal and learning outcomes), at present there is insufficient evidence to conclude that the relationships between various learning antecedents and learning outcomes are mediated by learning processes.

3.4 Discussion

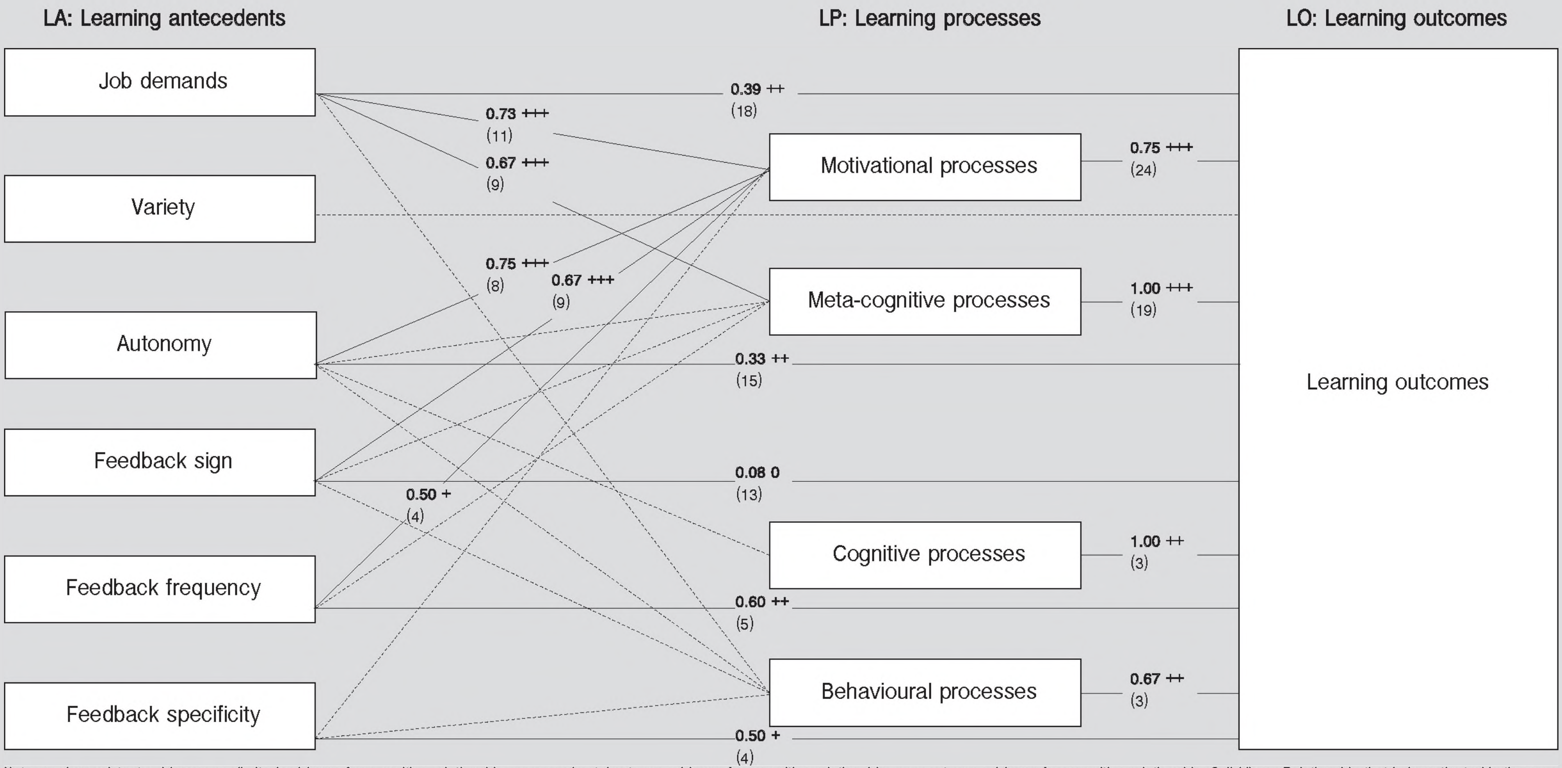
This review examined the strength of the evidence on the relationships among learning antecedents, processes and outcomes. We first construed a heuristic model for the relationships among task characteristics (antecedents), process-related concepts (motivation, meta-cognition, cognition and behaviour) and learning outcomes. We then conducted a systematic review of the literature, focusing on studies published in a selection of journals. Figure 3.2 summarizes our main findings.

What do we know?
How strong is the evidence for the relationship between task characteristics and learning outcomes? We found moderately strong evidence for a positive relation between job demands and autonomy on the one hand and learning outcomes on the other, suggesting that these task characteristics indeed promote learning. The fact that this evidence is *moderately* strong rather than strong might be due to nonlinearity, in that *excessively* high demands (or autonomy) may be 'overwhelming' (Karasek, 1998) and impede learning. Note that Karasek argues that it is the *combination* of high demands and high autonomy that facilitates learning, meaning that whether demands will be overwhelming depends on the level of control offered by the job. However, the studies included in the current review did not examine this issue, meaning that it is difficult to address this issue here.

Furthermore, similar to earlier reviews (e.g., Kluger & DeNisi, 1996), our review provided inconsistent support for a relationship between feedback sign and learning outcomes. Depending on the context, both positive and negative feedback may have beneficial consequences, e.g., negative feedback may be essential for improving suboptimal performance.

How strong is the evidence for the relationship between task characteristics and learning processes? Consistent with our hypotheses, we found strong evidence for positive relationships between job demands on the one hand and motivational and meta-cognitive processes (personal goal setting) on the other. Furthermore, autonomy as well as feedback sign were positively associated with motivational processes. Moreover, the research on the relationship between these task characteristics and cognitive or behavioural processes was also in line with our hypotheses. As regards the effects of feedback, it appears that the kind of feedback and the circumstances in which it is provided determine its impact on learning processes and learning outcomes (Hattie & Timperley, 2007).

Figure 3.2: What we know about the relation between learning antecedents, learning processes and learning outcomes; results based on **SIC** and the (number of studies)



Note: 0 = inconsistent evidence; + = limited evidence for a positive relationship; ++ = moderately strong evidence for a positive relationship; +++ = strong evidence for a positive relationship. Solid lines: Relationship that is investigated in three or more studies, reported in at least two papers. Dotted lines: Relationship that is investigated in less than two studies, or in three or more studies reported in the same paper.

How strong is the evidence for the relationship between learning processes and learning outcomes? Our review provided strong evidence for positive relationships among motivational as well as meta-cognitive processes (especially personal goal setting) and learning outcomes. Furthermore, there was moderately strong evidence for positive relationships between cognitive as well as behavioural processes and learning outcomes, supporting our hypothesis that these processes are positively associated with learning.

How strong is the evidence for the full model in Figure 3.1? Nine of the 11 studies investigating one of the intermediary learning processes in Figure 3.1 reported that the process under study mediated the relationship between specific learning antecedents and learning outcomes. Three of the four relevant studies showed that the relationship between goal difficulty and learning outcomes was mediated by personal goals. As the other seven studies examined varied types of relationships, these mediating relationships could not unambiguously be confirmed. However, in conjunction with the supportive evidence for the bivariate underlying relationships (antecedents-outcomes; antecedents-processes; and processes-outcomes), these results lend credit to the notion that learning processes indeed account for (part of) the relationships between task characteristics and learning outcomes. All in all, it seems justified to conclude that the relations of interest were either confirmed, or they were not tested sufficiently often in the selected journals. Perhaps most noteworthy, findings *dis*confirming our ideas were virtually absent. Thus, the model presented in Figure 3.1 and the hypotheses it represents seems a reasonable representation of the relationships among learning antecedents and outcomes, and the processes accounting for these associations.

Study limitations

The most important limitations of our research are the following. Firstly, our review was based on a heuristic model involving broad conceptualizations of its key concepts. Although this fitted our aim of mapping the available evidence in a broad perspective for the relationships in this model, it also resulted in the inclusion of many different measures for our core constructs. The differences among these measures might endanger the validity of our review, since these measures could represent different underlying constructs and processes.

Secondly, we restricted our literature search to studies published in high-impact journals. Application of our search criteria without this criterion resulted in an unmanageable number of potentially relevant studies (i.e., > 100,000 hits). By restricting our search to studies published in high-impact journals, we could reduce the number of hits to a manageable number in an objective and replicable way. However, this approach comes with the risk of *publication bias,* in that our selection of studies may "... overrepresent statistically significant findings, when compared to dissertations, unpublished manuscripts and conference presentations" (Sharpe, 1997, p. 882). It is possible that authors tend to send significant results to high impact journals, and null findings to low-impact journals. As we focused on high-impact journals only, it is possible that the impact of this publication bias is even stronger in the present study, leading to an even stronger overestimation of the actual effects. In this light it is noteworthy that our review included a substantial number of null findings: no less than 23% of the effects included in the present review were null effects (cf. Table 3.4). Further, as noted earlier, the impact factors of the journals included in the present review varied considerably, from 1.22 to 3.63. To obtain an indication of the magnitude of the publication bias in the present study, we conducted a logistic regression analysis in which we attempted to predict the presence of a significant finding (1 = statistically significant, 0 = null finding) by the impact factor of the journal in which this finding was published. The units in this analysis were the separate relationships tested in the present review, i.e., $n = 164$ (cf. Table 3.4). This analysis revealed no significant relationship between impact factor and the significance of the findings, Wald (1) = 0.42, $p = .84$, $R^2 = .03$. Thus, whereas our findings (as in any meta-analysis) may provide somewhat optimistic estimates of the strength of the relationships among the concepts studied, it appears that our restriction to high-impact journals did not severely impact the magnitude of the relationships reported here.

Thirdly, we did not conduct a methodological quality assessment of the studies included in our review (cf. De Lange, Taris, Kompier, Houtman & Bongers, 2002). This decision was made for two reasons. Firstly, a methodological assessment of 85 studies investigating a model that includes 24 relationships, varying in topic as well as study designs, would make the current paper extremely complicated. Secondly, by selecting the top-three ranking journals in ten scientific fields, we aimed to select the 'best evidence available' in the field (Slavin, 1995). Saha, Saint and Christakis (2003) reported a correlation of .82 between a journal's standing in the field (as rated by experts in this area) and its impact factor. Moreover, Lee, Schotland, Bacchetti and Bero (2002) found that "...articles of higher methodological quality are published in journals whose articles are cited more frequently (higher citations rates and impact factors.) [...] Journal citation rates and manuscript acceptance were the best predictors of the quality of research articles published in the journals" (p. 2807). Thus, it appears that a journal's impact factor is a reasonably valid indicator of its quality (Opthof, 1997). Having said that, not all studies published in high impact journals are high-quality studies by definition, and it is very likely that lower-impact journals also publish methodologically sound papers. It would seem likely that mediocre, uninteresting and unimportant papers will be cited less frequently than high-quality papers. This gives us a handle to assess – albeit indirectly – whether the individual papers included in our review belong to the low-quality, unimportant class of papers or to the class of high-quality papers we intended to include in our review. Using the ISI database, we calculated the average number of citations per year for all selected papers (i.e., total number of citations divided by the number of years passed since publication). This analysis showed that the selected papers were very frequently cited (M = 4.94, SD = 3.89). As the impact factors of the journals contributing papers to our review were all substantially lower than this average number of citations (ranging from 1.22 to 3.63), it is clear that the studies in our review generally belonged to the most-cited papers in these journals. Of course, it is possible that these studies were cited so often because they represent prime examples of bad research and implausible findings, but it seems extremely unlikely that such would apply to more than a few of the studies included in our review. Therefore, we conclude that these findings support our proposition that our selection procedure led to the inclusion of studies that are usually of at least acceptable quality.

Scientific implications: A research agenda

Learning antecedents. The findings of the experimental studies on autonomy and learning differed widely. Although it seems likely that autonomy and learning outcomes are related, focused experimental studies have at present not yet provided strong evidence for the psychological processes underlying this association. Given the conceptual centrality of autonomy for learning outcomes as well as the quite consistent associations between autonomy and learning outcomes that were demonstrated in survey research, more research is needed to investigate when autonomy is beneficial for learning outcomes.

Furthermore, we expected that job demands and autonomy would be nonlinearly related to learning processes and learning outcomes. A small number of studies in our review provided evidence for curvilinear effects. However, most studies were not designed to examine the shape of the relationships between demands (or autonomy) and learning processes and outcomes. It appears that this issue is most appropriately addressed in experimental designs that employ at least three conditions. Besides (at least) two conditions investigating whether job demands or autonomy is positively related to learning processes and outcomes, a condition with overwhelming job demands or autonomy should be involved;

for these overwhelming conditions, deterioration of learning may be expected (Karasek, 1998).

Causality of relationships. In many cases the causal direction of the effects reported in the studies included in this review could not be established unambiguously due to the designs used (e.g., cross-sectional designs), and this problem transfers to the present review as well. For example, in their repeated-measures study on goal setting and performance, Vancouver et al. (2001) reported that goal setting *negatively* influenced post-performance after controlling pre-performance. This runs contrary to the common hypothesis that setting difficult goals leads to better learning outcomes. In order to lend credit to causal interpretations of the relationships among these and other concepts in our heuristic model, it seems imperative that these relationships should be studied experimentally or longitudinally.

Full model. Most importantly, studies testing the full model presented in Figure 3.1 are sparse. From the 85 studies, only 11 studies investigated whether learning processes mediate the relationship between learning antecedents and learning outcomes. Although these studies provide some support for the idea that the relationship between task characteristics and learning outcomes is mediated through motivational, meta-cognitive, cognitive and behavioural processes, there is a need for more research into this issue.

Practical implications

We believe that the present review has some practical implications, especially with an eye to maximizing employee learning behaviour. First, our review showed strong positive relationships between job demands on the one hand and motivational and meta-cognitive processes on the other. These, in turn, were systematically related to learning outcomes. The strength of these relationships is such that it seems safe to assume that having high job demands is conducive to employee learning behaviour. Note, however, that these demands should not be overwhelmingly high; in such cases, adverse consequences for learning behaviour may be expected. Although these recommendations regarding the preferred structure of a worker's task have been voiced before (e.g., Karasek & Theorell, 1990), the present review is the first to show that these ideas are broadly supported across a wide range of studies, using both experimental and non-experimental paradigms.

Furthermore, it is interesting to see that both motivational and meta-cognitive processes (i.e., goal setting) are strongly and systematically related to the learning outcomes in this review. This suggests that it may be worthwhile for supervisors to check frequently on their subordinates' motivation and work goals. For example, it seems desirable that these issues are addressed regularly during work consultation and yearly performance interviews. In this way, supervisors may detect deficits in an early stage, meaning that serious problems in these respects can be dealt with timely and effectively.

In conclusion

The present review was designed to answer the question what high quality studies teach us about the relationship between task characteristics, learning processes and learning outcomes. It was based on a newly developed heuristic model, integrating five 'grand theories' in work and organizational psychology and related disciplines. Although the ideas presented in this model are intuitively plausible, it presents the first systematic attempt to integrate these notions into a single model that specifies how motivational, meta-cognitive, cognitive and behavioural processes mediate the effects of selected task characteristics (job demands, variety, autonomy and feedback) on learning outcomes. In this sense, we extend current theorizing on the effects of task characteristics on learning outcomes.

Based on our model, we conducted a systematic literature review that resulted in 85 empirical studies that appeared in high-impact journals, covering almost 40 years in total. These studies were coded and quantified using a newly developed measure, the standardized index of convergence (SIC). This index is a simple way to integrate the findings from a range of studies, especially when a formal meta-analysis that focuses on effect sizes is not possible or suitable. Interestingly, no relationships proposed in our model were disconfirmed; evidence regarding these relationships was either absent or consistent with our hypotheses. Thus, for the time being our model seems a reasonable reflection of the processes linking learning antecedents (i.e., task characteristics) and learning outcomes: Job demands, autonomy and feedback are positively related to learning outcomes, and these relationships are mediated through especially motivational and meta-cognitive processes. Although we would exaggerate our findings if we said that our study opened up the black box of learning antecedents, processes and outcomes, it seems fair to say that we at least peeked inside it.

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3

Chapter 4

Costs and benefits of autonomy when learning a task: An experimental approach

4

This chapter is based on:

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Abstract

Previous findings suggested that the positive relationship between autonomy and learning outcomes (such as improved task performance) only holds up until a certain optimum level of autonomy has been reached. This assumption was investigated in an experimental study where 95 participants had to learn a computer task. During the learning phase, we manipulated autonomy, distinguishing among no, moderate and full autonomy. The results revealed that, when learning a task, having autonomy is preferred to having no autonomy. However, increases in autonomy beyond a certain level (i.e., full versus moderate autonomy) will not yield additional advantages regarding the motivation to learn and learning outcomes, and may have disadvantages in terms of learning efficiency.

4.1 Introduction

In response to technological changes, new patterns of work and unemployment, health challenges and improvements, learning has become an essential part of our daily life (Marsick, Bitterman & Van der Veen, 2000). Research in the field of work and organizational psychology has shown that the extent to which learners learn new behavioural patterns differs among learners and depends on a variety of factors, especially environmental characteristics such as job design (e.g., Karasek, 1979; Taris & Kompier, 2005; Wielenga-Meijer, Taris, Kompier, & Wigboldus, 2006, Chapter 2 of this thesis). One such determinant of learning is the *level of autonomy* learners have (i.e., the degree to which a task offers freedom, independence and discretion to schedule its activities, to make decisions, and to select the methods to perform the (sub) task(s); Hackman & Oldham, 1975).

In line with this reasoning, three reviews provided evidence for a positive relationship between autonomy and learning outcomes such as improved task performance (Spector, 1986; Stewart, 2006; Wielenga-Meijer, Taris, Kompier & Wigboldus, 2010, Chapter 3 of thesis). However, the evidence for this relationship is not as strong as one might expect: The meta-analytical correlations between autonomy and learning outcomes in these studies ranged from .19 to .26. One explanation for this moderate (rather than strong) evidence for a positive relationship between autonomy and learning outcomes could be that this relationship is curvilinear. On the one hand, *lack* of autonomy during learning may be harmful for learning outcomes because learners do not have the opportunity to explore and learn new things. On the other hand, they can also have *too much* autonomy when learning a task (Warr, 2007); as Warr argues, "unremitting control [...] can give rise to overload problems as very high demands exceed personal capabilities" (p. 97). The primary aim of the current study is to investigate the assumption that autonomy is beneficial for learning, but only up to a certain optimum. Beyond this optimum, higher levels of autonomy will cease to be beneficial, as compared to moderate levels of autonomy. We also assume that full autonomy may lead to more inefficient behaviour, which is a disadvantage compared to moderate autonomy.

Furthermore, the positive effects of autonomy have been much more elusive in practice than current theoretical models have suggested (Langfred & Moye, 2004). This could be due to the fact that the psychological processes that link autonomy to learning outcomes are still poorly specified and sparsely studied. Thus, a second aim of the current study is to shed more light on this relationship by focusing on the motivational and behavioural processes connecting autonomy to learning outcomes.

Autonomy and learning outcomes

Learning is a theoretical construct, meaning that it must be separated from its observable records. Indeed, mixing up the theoretical construct of learning and possible observable changes in behaviour as a result of learning has created confusion over the years (Weiss, 1990). This confusion can be reduced by distinguishing learning *processes* (like motivational, cognitive and behavioural processes) from learning *outcomes* such as improved task performance. Following Weiss (1990), we define a learning outcome as "a relatively permanent change in knowledge or skill produced by experience" (pp. 172-173). Thus, learning may either involve an increase in knowledge or skills by the acquisition of additional (new) knowledge or skills, or a change in already acquired knowledge or skills. We propose that autonomy may affect learning outcomes via motivational and behavioural learning processes.

Motivational processes. Motivational theories such as the Job Characteristics Model (Hackman & Oldham, 1980) and Self-Determination Theory (Deci & Ryan, 1985) assume that autonomy will positively influence learning outcomes because of its positive impact on *motivation* (i.e., the "willingness to supply the effort necessary", Ouwerkerk, Meijman & Mulder, 1994, p.22). Autonomy when learning a task fosters learners' feelings of personal responsibility for the outcomes of their task, which is beneficial for learners' motivation to learn (e.g., Colarelli, Dean & Constantine, 1987; Wright & Cordery, 1999). Furthermore, high motivation to learn can increase persistence and willingness to explore alternative strategies, and may result in better learning outcomes (Bell & Kozlowski, 2008; Debowski, Wood & Bandura, 2001).

Behavioural processes. The Demand-Control model (Karasek & Theorell, 1990) proposes that a combination of high autonomy and high (but not overwhelming) job demands will stimulate active learning through *exploration behaviour*, including activities such as searching, experimentation, playing, discovering, varying and innovating (March, 1991). Learners who have autonomy have the opportunity to compare the effects of alternative strategies to see which strategy fits the task demands best. Through this behaviour, new strategies can be developed and old strategies improved (Taris & Kompier, 2005). Empirical studies have indeed found that systematic exploration behaviour influences learning outcomes positively (Goodman, Wood & Hendrickx, 2004; Van der Linden, Sonnentag, Frese & Van Dyck, 2001). Conversely, Trudel and Payne

(1995) found that autonomy led to more *inefficient* exploration, resulting in worse learning outcomes. Based on these findings, we assume that autonomy will lead to higher levels of exploration behaviour, which is essential for learning new strategies. However, it is possible that having too much autonomy leads to inefficient exploration behaviour, thus endangering the efficiency of attaining particular learning goals.

In sum, whereas previous research provided evidence for a positive relationship between autonomy and learning outcomes, this evidence is weaker than one might expect. This may be explained by assuming that autonomy is curvilinearly related to learning outcomes. Furthermore, it is still poorly understood which processes account for the effect of autonomy on learning outcomes. The present study was designed to deal with both issues. We propose that 1) autonomy will positively influence learning outcomes up until an optimal level of autonomy, and 2) this relationship will be mediated by motivational and behavioural processes.

The present study

Participants had to master a *puzzle task* in which they had to learn an optimal route in order to reach the performance goal. Participants had to figure out the mapping of the keys to be used during the task as well as the hidden structure of this mapping (which was unknown to the participants; see method section). This task was considered appropriate to examine learning in an experimental setting as it potentially enabled participants to increase their skills and knowledge in a relatively short time span and allowed for a convenient manipulation of autonomy. Moreover, previous research on learning in an experimental setting used similar paradigms with satisfactory results (e.g., Fazio, Eiser & Shook, 2004; Vollmeyer, Burns & Holyoak, 1996), underlining the usefulness of this type of paradigms for examining learning.

A baseline test was followed by (at least) ten practice trials in which autonomy was manipulated. In the no autonomy condition participants received strict instructions, teaching them the optimal route; they had no freedom to make any decisions or to select the methods to explore and perform the task. In the moderate autonomy condition, participants received guidance on how to conduct the task and had the opportunity to freely explore different routes. In the full autonomy condition, participants had full freedom to explore, but received no guidance.

As an operationalization of learning outcomes, we measured participants' task performance on a so-called transfer test in order to investigate to what extent they had learned new things. During this test, participants had to demonstrate how efficient they could reach the goal, while the hidden structure was the same as in the practice sessions, but where the mapping of the keys was different. Only participants who figured out the underlying structure of the original task could perform quickly on the transfer test.

Hypotheses. We expect (moderate and full) autonomy to be beneficial for learning outcomes, while full autonomy will not lead to better learning outcomes than moderate autonomy. We thus expect that (moderate and full) autonomy cause better task performance on the transfer test than no autonomy (*Hypothesis 1a)*, but full autonomy will not cause better task performance on the transfer test than moderate autonomy *(Hypothesis 1b)*[4].

We expect this relationship between autonomy and learning outcomes on the transfer test for two reasons: Having (an optimal level of) autonomy will stimulate 1) motivational and 2) behavioural processes. We thus propose that (moderate and full) autonomy will result in higher motivation to learn than no autonomy (*Hypothesis 2a*), while full autonomy will not lead to higher motivation to learn than moderate autonomy (*Hypothesis 2b*). Furthermore, we propose that (moderate and full) autonomy will result in more exploration behaviour than no autonomy (*Hypothesis 3a*) and that full autonomy will lead to more inefficient behaviour in such a way that full autonomy causes more exploration behaviour than moderate autonomy (*Hypothesis 3b*).

Finally, we consider motivation to learn and exploration behaviour as two processes that underlie the relationship between autonomy and learning outcomes. Therefore, we expect this relationship to be mediated by motivation to learn (*Hypothesis 4a*) and exploration behaviour *(Hypothesis 4b)*[5].

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4 These hypotheses (1a and 1b) aimed to investigate Research question 3a of this thesis (Table 1.1).

5 These hypotheses (2a, 2b, 3a, 3b, 4a and 4b) aimed to investigate Research question 3c of this thesis (Table 1.1).

4.2 Method

Participants

The sample included 95 undergraduate students who had not participated in previous (pilot) studies employing the same paradigm. Participants were given either course credit or €4 for their voluntary participation. The sample consisted of 20 men (21.1%) and 75 women (78.9%), with a mean age of 21.21 years (*SD* = 3.43).

Design: The Tom and Jerry task

Participants had to learn the newly developed 'Tom and Jerry task', in which participants had to learn how to catch Jerry as efficiently as possible during two practice sessions, including at least five practice trials per session. The task was pre-tested in a number of pilot studies during which the setup of the experiment (e.g., the way feedback was presented on the screen) was optimized. During one baseline and four performance tests, participants had to demonstrate their acquired knowledge and skills using less than 20 keystrokes to catch Jerry. Table 4.1 describes the chronological order of the experiment. During the practice as well as the test trials, participants received feedback on the screen, showing the number of keystrokes they had entered so far (cf. Bandura, 1997). Furthermore, after reaching Jerry, the total number of keystrokes the participants had needed to reach Jerry (the performance measure) was presented for 5 seconds.

The cover story of this experiment framed the new computer task as a game. In order to motivate participants, they were informed that a €10 book token would be awarded to the person with the best average performance score on the performance tests in each condition.

Baseline test. After receiving a general written instruction, participants started with a baseline test in order to control for pre-manipulation differences in performance. Before any manipulation took place and before anyone could learn from the practice trials, participants conducted this baseline test with the instruction to reach Jerry within 20 keystrokes.

Practice sessions/autonomy manipulation. The experiment involved two practice sessions, including at least five practice trials (see Table 4.1). The fifth practice trial of both practice sessions could be repeated as often as the participants desired. In effect, the participants conducted at least 2 × 5 obligatory practice trials, and possibly some extra practice trials. In the practice trials the participants had to figure out the meaning of each of the four keys (keys 1 - 4) controlling

Table 4.1: Flowchart of the experiment

	Baseline test	**Practice session 1: $\geq$ 5 practice trials**	**Standard test 1**	**Practice session 2: $\geq$ 5 practice trials**
Participants' goal	Reach Jerry within 20 keystrokes	Discover function of keys 1-4	Reach Jerry within 20 keystrokes	Discover function of keys 1-4
Theoretical and (actual) range of keystrokes	16 - 20 (19 - 199)	16 - ∞ (16 - 302)	16 - 20 (16 - 45)	16 - ∞ (16 - 182)
Range of extra practice trials		0 - 10		0 - 5

Standard test 2	Questionnaires	Warning test	Transfer test
Reach Jerry within 20 keystrokes	Perceived autonomy, Motivation to learn, Perceived exploration behaviour	Reach Jerry within 20 keystrokes	Reach Jerry within 20 keystrokes
16 - 20 (16 - 47)		16 - 20 (16 - 86)	16 - 20 (16 - 43)

Tom's movements, in order to discover how to perform optimally (i.e., to find the shortest route to Jerry). Pilot studies had shown that this number of practice trials was sufficient to reach the goal (i.e., to catch Jerry within 20 keystrokes). Autonomy was manipulated during all practice trials.

Performance tests. Each practice session (including five trials) was followed by a standard test (Table 4.1). After these standard tests, participants had to conduct a transfer test that was preceded by a warning test (which was identical to the transfer test, see below). Before each of these four tests, participants were told that they should reach Jerry within 20 keystrokes (16 keystrokes were needed at minimum), a difficult but attainable goal (cf. Locke & Latham, 2002).

During Standard test 1 and 2 (cf. Table 4.1), the meaning of the keys was exactly the same as in the practice sessions. These tests were intended to check whether all participants had learned in all conditions.

The transfer test tapped the extent to which participants could use the knowledge and skills they had learned during the practice sessions in a somewhat different environment. This test thus measured whether participants had learned *new* things. To this aim, the Tom and Jerry task contained a hidden structure: During all trials, *a midline* (invisible to the participants) divided the screen into a left and a right part. The keys took on a different meaning on the left and the right part of the screen (Figure 4.1). This hidden structure did not change across the practice and test trials. However, the mapping of the key functions (the meaning of the keys at the left and at the right screen parts) was reversed in the transfer test. For instance, the key '4' meant 'move upwards' in the *left* part of the screen during all previous trials, but in the transfer test this key would move Tom upwards in the *right* part of the screen. Pilot studies showed that it was necessary to prepare participants for this transfer test. Therefore, this test was preceded by a 'warning test' that was identical to the transfer test.

Autonomy manipulation

The experiment employed a one-factor between-subject design with three levels of autonomy: no autonomy, moderate autonomy and full autonomy. The autonomy manipulation was based on Hackman and Oldham's (1975) definition of autonomy and on the error management literature (e.g., Frese et al., 1991; Heimbeck, Frese, Sonnentag & Keith, 2003), where the strictness of the instructions and the opportunities to make mistakes were varied experimentally. In the *no autonomy* condition (NA), participants received precise instructions during the practice sessions concerning the most efficient way to reach Jerry: Prior to each keystroke, the key they had to use appeared on the screen. Moreover, participants had no freedom to explore alternative ways, since all 'wrong' keys were locked; they learned the single best way to reach Jerry. In the *moderate autonomy* condition (MA), participants received the same instructions during the practice sessions as in the no autonomy condition. However, the keys were unlocked. Participants thus had the opportunity to explore other routes to reach Jerry. Finally, in the *full autonomy* condition (FA) participants did not receive any instructions during the practice sessions concerning the keys they should use and the keys were unlocked. In effect, these participants had full freedom and discretion to make decisions, to explore, to discover the key functions and to learn the most efficient route to Jerry.

Measurements
All self-report variables were measured directly after Standard test 2 (see Table 4.1), so the performance of the transfer test could not affect these data. Demographic data were collected at the end of the experiment, after the transfer test.

Autonomy. Based on Hackman and Oldham's (1975) definition of autonomy, we developed a six-item questionnaire to check perceived autonomy ("I had the freedom to choose my own search strategy"; "During the practice sessions, I had the feeling that I could decide what to do, by myself"; "I was dependent of others, in discovering how this game works" (reversed); "I had freedom during the practice sessions", "I had the feeling that restrictions were imposed on me" (reversed); "I could decide how to perform during the practice sessions"). Participants rated these items on a Likert scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*), Cronbach's $\alpha = .89$.

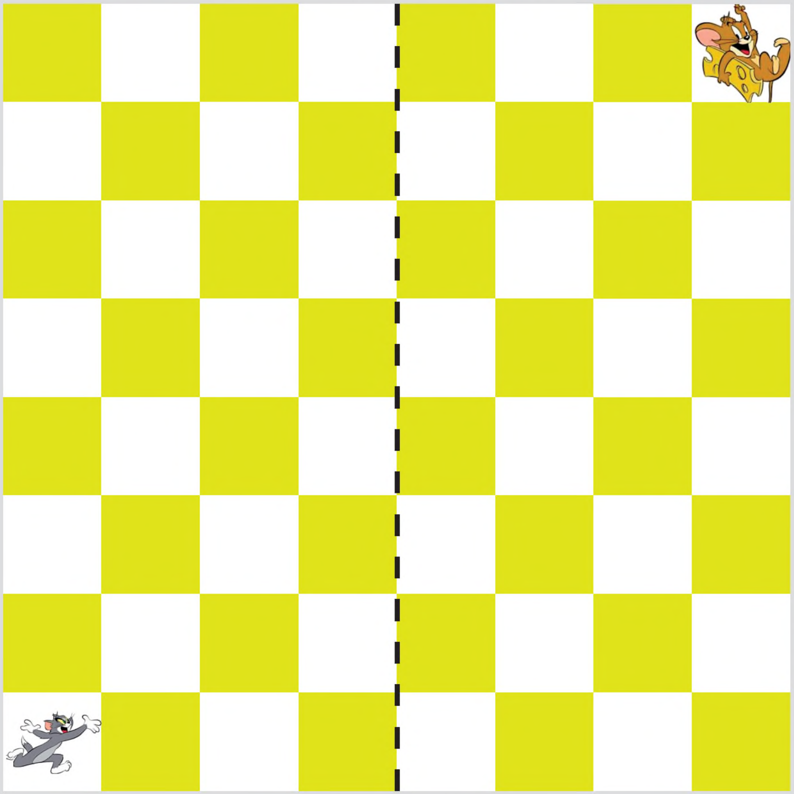
Motivation to learn. We measured motivation to learn with three self-constructed items. Following Vallerand (1997), we distinguished between the motivation to increase one's knowledge (item 1: "I was motivated to discover how the keys worked") and the motivation to accomplish things (item 2: "I was motivated to master this game"). As an overall measure of motivation, the third item of our scale was "I was motivated to learn in this game". Answering categories ranged from 1 (*strongly disagree*) to 7 (*strongly agree*), Cronbach's $\alpha = .89$.

Exploration behaviour. To examine exploration behaviour, we used a behavioural measure as well as a self-report questionnaire. Firstly, directly after Practice session 1 and 2, we measured the number of extra practice trials *(Extra practice trials 1 and 2)* taken by the participants at the end of each of the two practice

Figure 4.1: Starting screen of the Tom & Jerry task, including an explanation of the hidden structure

Mapping of the keys at the left part of the screen during the Baseline test, Practice session 1 & 2 and Standard test 1 & 2:
1: Tom moves downwards
2: Tom moves to the left
3: Tom moves to the right
4: Tom moves upwards

Mapping of the keys at the right part of the screen during the Baseline test, Practice session 1 & 2 and Standard test 1 & 2:
1: Tom moves upwards
2: Tom moves downwards
3: Tom moves to the left
4: Tom moves to the right



Mapping of the keys at the left part of the screen during the warning and the transfer test:
1: Tom moves upwards
2: Tom moves downwards
3: Tom moves to the left
4: Tom moves to the right

Mapping of the keys at the right part of the screen during the warning and the transfer test:
1: Tom moves downwards
2: Tom moves to the left
3: Tom moves to the right
4: Tom moves upwards

sessions. For convenience we combined the measures of Extra practice trials 1 and 2 in Table 4.2 and Table 4.3. Furthermore, we used two items to measure participants' *perceived exploration behaviour* ("I tried to discover the functions of the keys 1, 2, 3 and 4" and "I tried several things in order to understand the functions of the keys 1, 2, 3 and 4"), Cronbach's $\alpha = .73$. Answer alternatives ranged from 1 (*strongly disagree*) to 7 (*strongly agree*).

Learning outcomes. The transfer test reflected participants' performance in a new environment, signifying the extent to which participants had learned new things and were able to transfer the knowledge they had acquired. The number of keystrokes used during this test (the less keystrokes the better) is our operationalization of learning outcomes.

4.3 Results

Manipulation checks

In order to ascertain that all participants started at a similar level of competence, we conducted an ANOVA on the (pre-manipulation) baseline test for the three levels of autonomy. The participants did not perform differently during this baseline test across the three autonomy conditions, F (2, 92) = 1.44, $p > .05$, indicating that the participants in all conditions were initially equally competent.

To check the validity of the autonomy manipulation we conducted an ANOVA on perceived autonomy, F (2, 92) = 54.23, $p < .001$, $\eta^2 = .54$. Tukey's LSD range tests revealed that the means for perceived autonomy differed significantly across all three conditions (no autonomy: $M_{NA} = 2.16$, $SD_{NA} = 1.00$; moderate autonomy: $M_{MA} = 4.49$, $SD_{MA} = 1.46$; full autonomy: $M_{FA} = 5.28$, $SD_{FA} = 1.25$), thus supporting our manipulation of autonomy.

In order to investigate whether participants had learned to reach Jerry more efficiently during the learning phase, we conducted a repeated-measures MANOVA with performance (i.e., performance on the baseline test, Standard Test 1 and Standard Test 2) as a within-participants factor. The results showed increasing performance across these tests ($M_{\text{baseline test}} = 43.23$, $SD_{\text{baseline test}} = 27.99$; $M_{\text{Standard test1}} = 18.20$, $SD_{\text{Standard test1}} = 5.17$; $M_{\text{Standard test2}} = 17.11$ $SD_{\text{Standard test2}} = 4.34$), Wilks' Lambda (2, 93) = 43.76, $p < .001$, $\eta^2 = .49$. These results suggested that the participants had learned to reach Jerry more efficiently during the experiment.

Considering the performance on Standard test 2, an ANOVA with autonomy as independent variable showed significant differences among the groups, F (2, 92) = 4.48, p < 05, η^2 = .09. Tukey's LSD range tests showed that participants in the full autonomy condition needed significantly more keystrokes (M_{FA} = 18.91, SD_{FA} = 7.03) than participants in the no (M_{NA} = 16.09, SD_{NA} = 0.39) and moderate autonomy conditions (M_{MA} = 16.29, SD_{MA} = 1.62). Thus, after two practice sessions (including at least 10 practice trials), having no or moderate autonomy resulted in significantly better performance than full autonomy. Note that during Standard test 2, participants in the no as well as the moderate autonomy conditions closely approached the optimal performance of 16 keystrokes.

Descriptive data

Table 4.2 provides the means, standard deviations and correlations for all performance measurements, including task performance on the transfer test (our operationalization of learning outcomes), as well as the measures tapping motivation to learn and exploration behaviour (i.e., the number of extra practice trials and perceived exploration behaviour). Table 4.2 shows that participants on average needed less than 20 keystrokes, thus accomplishing the assigned performance goal (i.e., to reach Jerry within 20 keystrokes) during Standard tests 1 (M = 18.20) and 2 (M = 17.11). The increasing mean number of keystrokes during the warning test (M = 24.09) indicates the 'shock effect' of the changing functions of the keystrokes, from which participants recovered reasonably well during the transfer test, where they on average approached the assigned performance goal (M = 20.21).

Table 4.2: Means, standard deviations and correlations for the study variables

	M	*SD*	Range	1	2	3	4	5	6	7
1 Performance Standard test 1	18.20	5.17	16 - 45	-						
2 Performance Standard test 2	17.11	4.34	16 - 47	.14	-					
3 Performance warning test	24.09	10.06	16 - 86	.07	-.05	-				
4 Performance transfer test	20.21	5.04	16 - 43	.08	-.03	.25*	-			
5 Motivation to learn	5.55	1.21	1 - 7	-.05	.08	-.17	-.31**	-		
6 Extra practice trials	1.51	2.46	0 - 15	.10	.09	-.13	-.12	.13	-	
7 Perceived exploration behaviour	5.64	1.38	1 - 7	.20	.14	-.13	-.29**	.43***	.23*	-

Note: * p < .05; ** p < .01; *** p < .001.

Hypothesis tests

Planned contrast analyses were conducted to test Hypotheses 1 - 3. The first contrast compared the no autonomy versus the (moderate and full) autonomy conditions for the first part of these hypotheses (Hypotheses 1a, 2a and 3a). The second contrast compared the moderate autonomy versus the full autonomy condition (Hypotheses 1b, 2b and 3b). Table 4.3 presents the relevant F ratios (F_1 and F_2, respectively), as well as the F ratios for the univariate ANOVAs including all three experimental groups (F_{total}).

Autonomy and learning outcomes. Hypothesis 1 stated that having (moderate and full) autonomy would lead to better learning outcomes than having no autonomy (Hypothesis 1a); conversely, full autonomy would not result in better learning outcomes than moderate autonomy (Hypothesis 1b). An ANOVA on performance of the transfer test that contrasted all three experimental groups showed significant differences among the conditions, F_{total} (2, 92) = 3.81, $p < .05$, $\eta^2 = .08$ (Table 4.3). The first contrast (comparing no autonomy with autonomy) was significant, showing that participants in the moderate and full autonomy condition performed better on the transfer test than participants in the no autonomy condition. As predicted, the second contrast was not significant: The two autonomy conditions (MA and FA) did not differ significantly in terms of task performance on the transfer test (Hypotheses 1a and 1b supported).

Table 4.3: Descriptive data and results of univariate ANOVAs for learning processes and learning outcomes

	Conditions	*N*	*M*	*SD*	F_{total} (2, 92) (η^2)	F_1 (1, 92) (η^2)	F_2 (1, 92) (η^2)
Performance transfer test	NA MA FA	32 31 32	22.13 19.55 18.94	6.36 4.80 2.88	3.81* (.08)	7.35** (.07)	0.25 (.00)
Motivation to learn	NA MA FA	32 31 32	5.14 5.67 5.87	1.39 1.11 1.00	3.26* (.07)	6.06* (.06)	0.44 (.00)
Extra practice trials	NA MA FA	32 31 32	0.66 1.07 2.78	1.29 1.59 3.41	7.68** (.14)	6.44* (.07)	8.77** (.09)
Perceived exploration behaviour	NA MA FA	32 31 32	4.83 5.85 6.23	1.68 1.07 0.86	10.74*** (.19)	19.94*** (.18)	1.44 (.02)

Note: NA = No autonomy; MA = Moderate autonomy; FA = Full autonomy; F_{total} = univariate analyses contrasting all three autonomy conditions; F_1= Planned contrast analyses contrasting NA versus MA and FA; F_2= Planned contrast analyses contrasting MA versus FA;
* $p < .05$, ** $p < .01$, *** $p < .001$.

Because not all measures were normally distributed, all analyses reported in this table were also conducted with logtransformed data. The conclusions using the logtransformed data did not differ from what was concluded using the raw data. For simplicity this table presents the raw data.

Autonomy and the learning processes. Hypothesis 2 proposed that (moderate and full) autonomy would result in higher *motivation to learn* than no autonomy (Hypothesis 2a), while full autonomy would not result in higher motivation to learn than moderate autonomy (Hypothesis 2b). ANOVA showed significant differences in motivation to learn among the conditions, F_{total} (2, 92) = 3.26, $p < .05$, $\eta^2 = .07$ (Table 4.3). Planned contrast analyses confirmed that these differences were due to differences between the two autonomy conditions versus the no autonomy condition, and not to differences between the moderate and full autonomy conditions (Hypothesis 2a and 2b supported).

We hypothesized that having autonomy (MA and FA) would lead to more *exploration behaviour* than having no autonomy (Hypothesis 3a) and that full autonomy would cause more exploration behaviour than moderate autonomy (Hypothesis 3b). MANOVA on both measures of exploration behaviour for the autonomy manipulation revealed a significant overall effect of autonomy, Wilks' Lambda, F (4, 182) = 7.97, $p < .001$, $\eta^2 = .15$. Separate ANOVAs for each of the two measures of exploration behaviour confirmed that the three autonomy conditions differed in the number of extra practice trials taken by the participants, F_{total} (2, 92) = 7.68, $p < .01$, $\eta^2 = .14$, as well as in perceived exploration behaviour, F_{total} (2, 92) = 10.74, $p < .001$, $\eta^2 = .19$ (Table 4.3). Planned contrast analyses, contrasting no autonomy versus the (moderate and full) autonomy conditions, showed that for both variables measuring exploration behaviour, moderate and full autonomy led to more exploration behaviour than no autonomy (Hypothesis 3a supported).

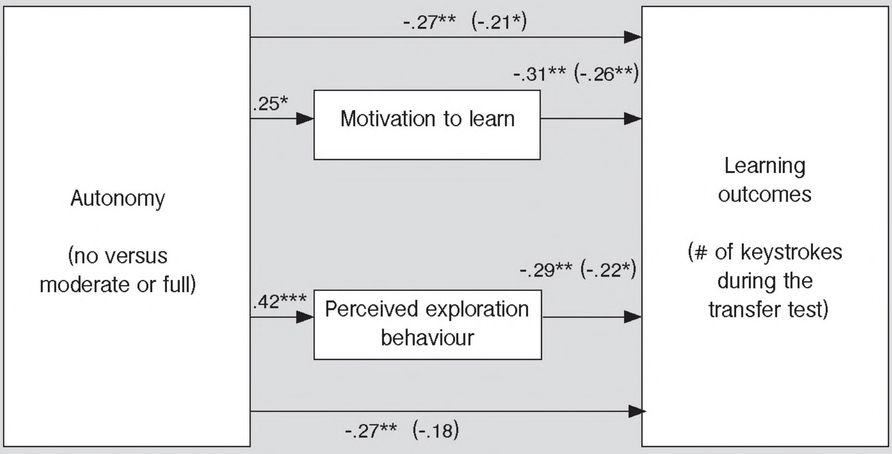
Contrasting moderate versus full autonomy showed that full autonomy led to usage of more extra practice trials than moderate autonomy. However, for perceived exploration behaviour, no significant differences were found between the moderate and full autonomy conditions (Hypothesis 3b supported for the extra practice trials, but not for perceived exploration behaviour).

Mediation analyses

In order to test whether motivation to learn (Hypothesis 4a) and exploration behaviour (Hypothesis 4b) mediated the relationship between autonomy and learning outcomes (performance on the transfer test) we used Baron and Kenny's (1986) four-step regression procedure. As the results obtained for Hypotheses 1a, 2a, and 3a all showed significant differences between the no autonomy versus the (moderate and full) autonomy conditions, we dummy-coded autonomy as 0 (no autonomy) versus 1 (moderate and full autonomy).

The four-step regression procedure showed that *motivation to learn* as well as *perceived exploration behaviour* fulfilled all four steps. That is, autonomy and learning outcomes were significantly related (Step 1); autonomy and the mediating variables motivation to learn and perceived exploration behaviour were related (Step 2); and the mediating variables and learning outcomes were significantly related (Step 3; see Figure 4.2). Both motivation to learn and perceived exploration behaviour accounted for a unique part of the variance in task performance on the transfer test. These variables explained 7% and 4% additional variance, respectively, beyond the 7% of variance explained by autonomy. The effect of autonomy on learning outcomes ($\beta = -.27$, $p < .01$) decreased (Baron and Kenny's Step 4) after controlling for motivation to learn (to $\beta = -.21$, $p < .05$), as well as after controlling for perceived exploration behaviour (to $\beta = -.18$, *ns*), see Figure 4.2. According to the Sobel test, however, both hypothesized mediators caused a non-significant decrease (*Z*s were 1.74, $p = .08$, and 1.80, $p = .07$, respectively).

Figure 4.2: Mediation model for the association between autonomy and learning outcomes, as mediated by motivation to learn and perceived exploration behaviour



Note: * $p < .05$; ** $p < .01$; *** $p < .001$

The numbers indicate standardized β's. Numbers in parentheses represent the relationship between autonomy and learning outcomes after controlling for the mediating variables.

Contrary to the variables motivation to learn and perceived exploration behaviour, the variable usage of *extra exploration* trials did not fulfil all 4 steps and did not explain additional variance. This suggests that this variable did not mediate the relationship between autonomy and learning outcomes.

In addition to these mediation analyses, we conducted a multiple mediator analysis (Preacher & Hayes, 2008) to check whether the *combination* of motivation to learn and perceived exploration behaviour mediated the relationship between autonomy and learning outcomes. This analysis showed that the effect of autonomy on learning outcomes ($b = 2.89$, $p < .01$) decreased significantly after controlling for both motivation to learn and perceived exploration behaviour ($b = 1.73$, *ns*), $Z = 2.05$, $p < .05$. Thus, motivation to learn and perceived exploration behaviour *jointly* mediated the effect of autonomy on learning outcomes (measured as task performance during a transfer test).

4.4 Discussion

The current study focused on the relationship between autonomy and learning outcomes. Its primary aim was to test the assumption that autonomy is beneficial for learning outcomes until an optimal level of autonomy is reached. Beyond that optimum, higher levels of autonomy should not improve learning outcomes. A second aim of this study was to investigate what processes account for the relationship between autonomy and learning outcomes. In order to address these issues, we distinguished among three levels of autonomy in an experimental study where participants had to learn a new computer task.

We found that that having no or moderate autonomy led to close-to-optimal performance when the test situation required the participants to repeat previously learned behaviour in exactly the same way. Conversely, participants having full autonomy performed significantly worse in this situation. However, in a transfer task where participants had to use the acquired knowledge and skills in a slightly different way, participants having no autonomy were clearly at a disadvantage compared to participants having (moderate and full) autonomy. However, full autonomy did not provide additional advantages compared to moderate autonomy. The latter finding may explain the relatively weak evidence that was found in three earlier reviews on the relationship between autonomy and learning outcomes (Spector, 1986; Stewart, 2006, Wielenga-Meijer et al., 2010). These reviews may have included studies investigating the effect of moderate autonomy (i.e., enough to learn the required behaviours) versus full (that is, too much) autonomy -- i.e., the part of the curve representing the relationship between autonomy and learning outcomes beyond the optimum level of autonomy. These studies (e.g., Trudel & Payne, 1995) reported nonsignificant or even negative relationships between autonomy and learning outcomes, thus negatively influencing the strength of the evidence for the relationship under study.

Motivational processes. The current study further examined the relationship between autonomy and motivation to learn. Interestingly, participants having moderate and full autonomy were equally motivated to learn during this experiment, and they were more motivated than participants having no autonomy. Thus, similar to the relationship between autonomy and learning outcomes, the positive influence of autonomy on motivation to learn was curvilinear. Indeed, providing even higher levels of autonomy may well lead to higher levels of frustration and to a decrease in motivation (cf. Deci & Ryan, 1985; Warr, 2007).

Behavioural processes. The behavioural measure of exploration behaviour was positively and linearly affected by autonomy. As expected, participants in the full autonomy condition used more extra practice trials during the practice sessions than participants in the moderate autonomy condition. This is an interesting point, since full autonomy had the same beneficial consequences as moderate autonomy in terms of participants' learning outcomes, motivation to learn and perceived exploration behaviour. Apparently, providing full autonomy may yield the same benefits for learning outcomes as providing moderate autonomy. However, participants having full autonomy needed more time (i.e., more practice trials) to reach this result.

Costs and benefits of autonomy

In conclusion, our study revealed that moderate autonomy is beneficial compared to no autonomy because it increases motivation to learn, exploration behaviour and learning outcomes (measured as task performance during a transfer task). Moreover, moderate autonomy is also preferred to full autonomy, because 1) full autonomy does not provide additional benefits considering participant's motivation to learn and learning outcomes, 2) in the full autonomy condition more exploration behaviour is needed to reach the same results as in the moderate autonomy condition, and 3) performance in the full autonomy condition is worse on a test situation that is identical to the learning phase, as compared to moderate autonomy. This implies that from a costs-benefits viewpoint, moderate autonomy must clearly be preferred to both having no as well as full autonomy.

Mediating pathways

The secondary aim in the current study was to investigate what processes may account for the relationship between autonomy and learning outcomes. We found that motivation to learn and perceived exploration behaviour jointly mediated this relationship. This study thus provided evidence for the notion that autonomy positively influences learning outcomes, because of its positive effects on motivation to learn and exploration behaviour.

Strengths of this study

Our finding that too much autonomy may not be beneficial (and perhaps even harmful) for learning outcomes, corroborates previous notions (Langfred, 2004; Warr, 2007). However, to the best of our knowledge, this is the first study to incorporate three levels of autonomy in examining its effects on learning and learning outcomes, rather than employing a crude 'little versus much autonomy' design. Contrary to earlier research, this study enabled us to test rather than to merely speculate about the idea that autonomy is curvilinearly related to various outcome measures.

Furthermore, the current study extends our knowledge on the processes that link autonomy to learning outcomes. Apparently, one of the reasons why autonomy positively influences learning outcomes is that the presence of autonomy triggers two processes. Firstly, autonomy fosters people's motivation to learn, possibly because of increased feelings of personal responsibility, and increased levels of challenge. Secondly, autonomy promotes the extent to which participants display exploration behaviour. Our study provided convincing evidence that these two processes account for a substantial part of the relationship between autonomy and learning outcomes.

Future Research

Some limitations of this study follow from its experimental design and the study population. Although this approach allowed us to examine the effects of varying amounts of autonomy on learning outcomes in a carefully controlled setting, the external validity of this design is relatively low; it is unclear whether the findings obtained here are strong enough to be of practical interest in a real-life environment. Even thought the findings reported here are suggestive, it is important that our results be replicated in a more naturalistic setting.

A second potentially interesting issue concerns the extent to which the motivational and behavioural processes studied in the present research affect each other. For example, do motivation to learn and exploration behaviour affect learning outcomes independently from each other, do higher levels of motivation to learn lead to more exploration behaviour, or does exploration behaviour (and the higher levels of learning resulting thereof) lead to higher levels of motivation? The present study showed that motivation to learn and exploration behaviour mediated the relationship between autonomy and learning outcomes jointly, but not separately. This makes the topic of mutual associations between motivation and exploration even more interesting. This issue could be addressed in experimental studies manipulating these processes, or, alternatively, in a longitudinal survey study taking multiple measures of these concepts.

Furthermore, the present study treated autonomy as a unidimensional variable. However, actually *two* aspects of autonomy were manipulated, namely the opportunities to explore freely (by (un-)locking particular keyboard keys) and the amount of information provided about the task to be conducted (the instructions). The effects of both aspects of autonomy were studied jointly, meaning that no insight was obtained in whether they differentially affected learning. On the one hand this limits the generalizability of our findings, in that other research on learning and autonomy often focused on the degree to which participants could decide for themselves how to conduct a task, rather than on the effect of receiving guidance (but note Frese et al., 1991; Heimbeck et al., 2003, where manipulations of autonomy were used that were similar to ours). However, on the other hand the inclusion of providing instructions increased the external validity of our study, as in applied settings (e.g., at work) people will often receive some form of guidance when learning a new task. Follow-up studies may study these aspects separately to obtain more insight into their possibly distinct effects on learning.

Fourthly, our study differentiated among no, moderate and full autonomy. Our findings suggest that these can labelled as 'too little', 'sufficient' and 'too much' autonomy. However, there are no strong criteria that distinguish too little or too much autonomy from sufficient autonomy. Therefore, in practice, criteria will need to be developed and tested for a variety of learning settings, examining when autonomy is too little, too much, and most importantly, sufficient, given the specific learning setting and the tasks at hand.

Fifthly, in order to increase our insight considering the (curvilinear) relationship between autonomy and learning, it may be interesting to investigate how this relationship will be affected by interruptions when learning a new task. We recommend that future studies will conduct experimental studies in which the level of autonomy is manipulated, as well as the interruptions (e.g., occurrence of interruptions, or the degree to which the interruptions are disturbing).

Finally, individual differences such as action styles and goal orientation may affect the relationship between autonomy and learning outcomes (cf. Frese & Zapf, 1994; Taris & Kompier, 2005; Taris & Wielenga-Meijer, 2010; Wielenga-

Meijer et al. 2006). For example, it would seem plausible that action-oriented learners will be better able to take advantage of any degree of autonomy (cf. Kuhl & Beckmann, 1994). Therefore we recommend that future studies will investigate the role of such individual differences in the relationship between task characteristics and learning.

Practical implications

An important practical implication concerns the curvilinear effect of autonomy on learning outcomes. This means that when people should 'learn while doing', it is important that they possess sufficient, but not too much autonomy, that is, that having moderate levels of autonomy is better than full or no autonomy. This statement seems inconsistent with the findings reported in this study, as Table 4.3 shows that having moderate and full autonomy both result in more advantageous outcomes in terms of performance, motivation and learning than having no autonomy. As the moderate and full autonomy conditions did not differ in these respects, it seems that what matters is that participants have *some* degree of autonomy rather than no autonomy, and that the precise amount of autonomy is unimportant. However, Table 4.3 also shows that participants in the full autonomy condition required significantly *more practice trials* to reach the same outcomes (e.g., motivation and performance) as those in the moderate autonomy condition. Thus, whereas participants in both conditions ultimately reached the same level of motivation and performance, those who received instructions obtained these results faster and more efficiently than those who did not receive instructions. Thus, receiving instructions is functional, even if it does not affect the scores on the main study concepts. For example, when newcomers in a job must become familiar with their jobs, the absence of autonomy may well result in low motivation, little exploration behaviour and low levels of learning, resulting in low task performance (Taris & Kompier, 2005). However, when *too much* autonomy (and too little guidance) is provided, new workers may in time possibly reach similar levels of performance as those having only adequate levels of autonomy, but they may well need more time and effort to reach this level of performance. Therefore, employers should provide enough (rather than 'overly high') autonomy to workers by providing clear guidance with respect to the job content and performance standards. In order to stimulate learning in the most efficient way, they should also provide room for exploration in a supportive context.

Secondly, it is interesting to see that the combination of motivation to learn and perceived exploration behaviour accounts for the relationship between autonomy and learning outcomes. Therefore, in a work setting, supervisors should check frequently on their subordinates' motivation and work goals. For example, it seems desirable that these issues are addressed regularly during work consultation and yearly performance interviews. In this way, supervisors may detect deficits in an early stage, meaning that serious problems in these respects can be dealt with.

All in all, autonomy is an important antecedent of learning outcomes, since it motivates and provides the opportunities to explore. However, having too much of a good thing (autonomy) may lead to inefficient learning processes, and it even may be harmful for learning outcomes. In order to facilitate learning a new task, we recommend that learners should have opportunities to explore new ways of doing their task as well as receive sufficient guidance to facilitate the learning process.

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Chapter 5

Don't bother me: Learning as a function of task autonomy and cognitive demands

5

This chapter is based on:

Wielenga-Meijer, E.G.A., Taris, T.W., Wigboldus, D.H.J., & Kompier, M.A.J. (submitted). *Don't bother me: Learning as a function of task autonomy and cognitive demands.*

Abstract

This study aimed to obtain more insight into the relationship between task autonomy and learning outcomes, examining why various levels of task autonomy differ in their learning outcomes. We conducted an experimental study in which 119 undergraduate students learned a computer task. During the learning phase, (no versus moderate versus. full) autonomy and cognitive demands (cognitively undemanding versus cognitively demanding interruptions) were manipulated in a 3 x 2 between-participants design. The results showed that in the no and full autonomy conditions, receiving cognitively demanding interruptions decreased learning outcomes compared to receiving cognitively undemanding interruptions. However, having moderate autonomy resulted in equally positive learning outcomes in both cognitive demands conditions. Having autonomy while learning a new task is essential, however, having too much autonomy may lead to adverse learning outcomes when cognitive demands are high.

5.1 Introduction

It is often acknowledged that the acquisition of new skills and knowledge has become an essential part of our daily lives (e.g., Marsick, Bitterman & Van der Veen, 2000). Many of these skills and knowledge are learned spontaneously and informally, that is, in contexts that -- unlike school and training -- are not especially designed for learning (Marsick & Watkins, 2001). Previous research has suggested that the extent to which people learn new behavioural patterns depends on a variety of personal and contextual factors, among which the degree to which people have the opportunity to explore different ways of solving a task (Karasek, 1979; Taris & Kompier, 2005). This largely depends on the level of *task autonomy* people have, i.e. the degree to which they have the freedom, independence and discretion to schedule their tasks, to make decisions, and to select the methods to perform tasks (Hackman & Oldham, 1975). Previous reviews (Spector, 1986; Steward, 2006; Wielenga-Meijer, Taris, Kompier, & Wigboldus, 2010; Chapter 3 of this thesis) revealed moderately strong evidence for a positive relationship between autonomy and learning outcomes (such as improved task performance). The strength of this evidence was not as strong as one might expect, which may be due to inconsistent findings: Although most studies included in these reviews reported that autonomy and learning outcomes were positively associated, other studies found no or reversed effects of autonomy. For example, Heimbeck, Frese, Sonnentag and Keith (2003) found that enactive exploration (involving high levels of autonomy) when learning a new task was beneficial for learning outcomes, compared to receiving strict instructions (leading to very low levels of autonomy). However, Debowski, Wood and Bandura (2001) reported the reversed result (cf. Keith & Frese, 2008).

These inconsistent findings suggest that there may be a curvilinear relationship between autonomy and learning outcomes (Warr, 2007). On the one hand, *lack* of autonomy during learning may be harmful for learning outcomes, because learners do not have the opportunity to explore and learn new things. On the other hand, one can also have *too much* autonomy when learning a task. As Warr argues, "opportunities for control and use skills (i.e., autonomy) are expected to give rise to decrements [in learning] because an 'opportunity' becomes an 'unavoidable requirement' at very high levels [of autonomy]; behaviour is then coerced rather encouraged. Unremitting control [...] can give rise to overload problems as very high demands exceed personal capabilities" (p. 97). In line with this reasoning, Langfred (2004) found that having too much autonomy was associated with adverse learning outcomes. Similarly, Wielenga-Meijer, Taris, Wigboldus and Kompier (in press, Chapter 4 of this thesis) demonstrated that the positive effect of autonomy on learning outcomes was curvilinear. Their study, in which three levels of autonomy (no, moderate and full autonomy) were varied systematically, revealed that having moderate or full autonomy was beneficial for learning outcomes (i.e., better task performance) compared to no autonomy. This relationship was mediated by the *motivation* to learn the task (cf. Dickinson, 1995; Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004), where motivation can be defined as "the willingness to supply the effort necessary" (Ouwerkerk, Meijman & Mulder, 1994, p.22). The latter effect is in line with findings showing that lack of autonomy may be frustrating (Eichar, Norland, Brady, & Fortinsky, 1991; Larsen, 2005). Importantly, however, although both moderate and high levels of autonomy in Wielenga-Meijer et al.'s study (in press) were beneficial for learning outcomes and motivation, having moderate autonomy was associated with more efficient learning behaviour than having full autonomy: Participants in the former condition needed less practice time to reach the same level of performance.

These results may be accounted for by assuming that different levels of autonomy appeal to various levels of information processing capacities. Learning a new task when having full autonomy (and consequently no guidance) will require more expenditure of cognitive resources than learning the same task under conditions of moderate autonomy. The present study was designed to test this reasoning by examining the influence of autonomy on learning outcomes, while experimentally varying the information processing capacities available for conducting this task. This was done by interrupting the process of learning a new task with a secondary task that was systematically varied regarding the degree to which it appealed to one's information processing capacities. Basically, we assumed that experiencing cognitively demanding (i.e., complex and difficult) interruptions when learning a task will impede participants' ability to spend effort and information processing capacities on the primary task that should be learned, while cognitively undemanding (i.e., simple and easy) interruptions will leave participants' cognitive capacities for the primary task relatively undisturbed.

The learning process interrupted

Interruptions are "externally generated, temporary cessation[s] in the current flow of behaviour, typically meant to execute activities that belong to a secondary set of actions" (Van den Berg, Roe, Zijlstra & Krediet, 1996, p. 236). The nature of the interrupting activity, in particular its similarity to the main task (Gillie & Broadbent, 1989), its complexity in terms of information processing demands (Hodgetts & Jones, 2006), and its timing (Monk, Boehm-Davis & Trafton, 2002), influence the extent to which an interruption is demanding and disruptive, and therefore potentially negative for learning outcomes during a learning process (e.g., Cellier & Eyrolle, 1992; Eyrolle & Cellier, 2000).

In line with action theory (Frese & Zapf; 1994; Hacker, 1998), a behaviour-oriented approach that focuses on the cognitive regulation of actions, we assume that the occurrence of interruptions may affect the regulation process during learning in several ways. Firstly, interruptions put additional demands on the resources needed to execute the action plans for the activity as a whole, including the interrupting events (Zijlstra, Roe, Leonova & Krediet, 1999), which means that individuals must be motivated to put this additional effort into both activities. Secondly, when a learning task has been interrupted, learners cannot 'complete their thoughts' and therefore they are unable to develop new action plans. As a result much cognitive regulation is required.

The present study

In this study we aimed to obtain more insight into the reasons why various levels of autonomy lead to different learning outcomes when learning a new task. Specifically, we investigated whether having full autonomy is disadvantageous compared to moderate autonomy, because the former condition requires more information processing capacities. To this aim we conducted an experimental study in which autonomy and cognitive demands were manipulated. Participants were asked to learn a new computer task: The 'Tom and Jerry task' (see also Wielenga-Meijer et al., in press). While participants were learning this task, they were interrupted several times with either cognitively demanding (i.e., complex and difficult) or undemanding (simple and easy) tasks.

In the Tom en Jerry task, participants had to learn how to bring Tom (the cat) to Jerry (the mouse) in two *practice sessions* of five practice trials each, using keyboard keys 1-4. In order to catch Jerry, participants had to learn the mapping of these keys as well as the hidden structure of this mapping (which was unknown to the participants): The keys took on a different meaning on the left and the right part of the screen.

During the ten practice trials, autonomy was manipulated and participants had to solve IQ test items that differed in cognitive demands. In the no autonomy condition participants received strict instructions, teaching them how to catch Jerry; they had no freedom to make any decisions or to select the methods to explore and perform the task. In the moderate autonomy condition, participants received guidance on how to conduct the task and had the opportunity to freely explore different routes. In the full autonomy condition, participants had full freedom to explore, but received no guidance.

Finally, to investigate participants' learning behaviour, participants had to demonstrate how efficiently they could move Tom to Jerry during so-called *transfer tests* in which the hidden structure was the same as in the practice sessions, but where the mapping of the keys was different. That is, only participants who figured out the underlying structure of the original task were able to perform quickly on a transfer test.

Hypotheses. We hypothesized an interaction effect for autonomy of the learning task and the cognitive demands of the interruptions on learning outcomes, measured as task performance during the transfer tests (Hypothesis 1). We assumed that learning a new task would require more information processing capacities when having full autonomy compared to having moderate autonomy. If so, the differences in learning outcomes between the cognitively demanding and undemanding interruption conditions should be larger for participants having full autonomy than for participants in the moderate autonomy condition (*Hypothesis 1a*)[6]. In the full autonomy condition, participants need their cognitive resources to learn the new task, while they must also use these resources to solve the cognitively demanding interruptions. Solving demanding interrupting tasks will hinder participants to use these resources for the learning task. Conversely, the undemanding interruptions appeal less strongly to participants' cognitive resources. In this condition, the available resources are sufficient to learn the new task, also in the full autonomy condition.

For the no autonomy condition, we also expected that the differences in learning outcomes between the demanding and undemanding interruption conditions would be larger than in the moderate autonomy condition (*Hypothesis 1b*). This hypothesis is based on studies showing that motivation mediates the relationship between autonomy and learning outcomes (Vansteenkiste et al., 2004; Wielenga-Meijer et al., in press, Zhou, 1998), and that lack of autonomy can be frustrating (Eichar et al., 1991; Larsen, 2005). In line with these studies, on an exploratory basis we examined the effect of autonomy on two aspects of motivation: task pleasure and motivation to learn. We expected that having no autonomy would lead to lower ratings on these measures than having moderate and full autonomy.

6 This hypothesis aimed to investigate Research question 3b of this thesis (Table 1.1).

Finally, personal characteristics may also influence the extent to which people will learn. Two personal characteristics have been shown to moderate the influence of autonomy on learning outcomes namely personal initiative (Frese, Fay, Hilburger, Leng & Tag, 1997, Taris & Wielenga-Meijer, 2010) and need for cognition (Nair & Ramnarayan, 2000). In the present study both variables will be controlled for.

5.2 Method

Participants

The sample included 133 undergraduate students who had not participated in previous (pilot) studies employing the same paradigm and who reported that they had understood the instructions (at least moderately) well. Participants were given either course credit or € 7.50 for their voluntary participation. The sample consisted of 18 men (13.5%) and 115 women (86.5%), with a mean age of 20.80 years (SD = 2.48).

Design: The Tom and Jerry task with interruptions

The present study employed a 3 (autonomy: no versus moderate versus full) × 2 (cognitive demands: cognitively demanding versus undemanding task interruptions) between-subjects design. In the Tom and Jerry task participants had to learn how to catch Jerry as efficiently as possible during two practice sessions of five practice trials each. During five performance tests (one baseline, two standard and two transfer tests), participants had to demonstrate their (acquired) knowledge and skills in catching Jerry (Table 5.1 presents the chronological order of the experiment). The participants continuously received feedback on the screen during all trials, showing the number of keystrokes they had used so far (cf. Bandura, 1997). Furthermore, the total number of keystrokes the participants had needed to catch Jerry was presented on the screen for 5 seconds after they had reached the mouse.

Participants were told they were taking part in a multitasking experiment, in which a computer game (i.e., the Tom and Jerry task) was interrupted by puzzles (the IQ test items). In order to motivate them to put effort into this experiment, participants were informed that a €10 book token would be awarded to the person with the best overall performance score.

Table 5.1: Flowchart of the experiment

	Baseline test	Practice session 1*: 5 practice trials	Standard test 1	Practice session 2*: 5 practice trials	Standard test 2	Questionnaires	Transfer test 1	Transfer test 2	Questionnaires
Theoretical (and actual) range of keystrokes	16 - 20 (19 - 168)	16 - ∞ (16 - 341)	16 - 20 (16 - 74)	16 - ∞ (16 - 266)	16 - 20 (16 - 45)	Task pleasure Motivation to learn Mental load Interruptions	16 - 20 (16 - 66)	16 - 20 (16 - 41)	Personal Initiative Need for Cognition Demographics
Range of time (seconds) on the interruptions, per interruption		1.97 - 15.00		2.95 - 15.00					

Note: * Levels of autonomy (no vs. moderate vs. full) and demandingness (cognitively undemanding vs. demanding) were varied across conditions.

Baseline test. After reading a written general instruction, participants started with a *Baseline test* to control for pre-manipulation performance differences. Before any manipulation took place and before anyone could learn from the practice trials, participants conducted this test with the instruction to reach Jerry within 20 keystrokes.

Practice sessions/manipulations. The participants conducted 2 × 5 *practice trials* that were all interrupted (cf. Table 5.1). In these trials the participants had to figure out the meaning of each of the four keys (keys 1- 4) controlling Tom's movements, in order to discover how to perform optimally (i.e., to find the shortest route to Jerry). Pilot studies had shown that this number of practice trials was sufficient to reach the goal (i.e., to catch Jerry within 20 keystrokes). Autonomy as well as cognitive demands of interruptions were manipulated during these practice sessions.

Performance tests. Both practice sessions (including five trials each) were followed by a standard test (Table 5.1). After these tests, participants had to conduct two transfer tests. Before each of these four tests, participants were told that they should reach Jerry within 20 keystrokes (16 keystrokes were needed at minimum), a difficult but attainable goal (cf. Locke & Latham, 2002).

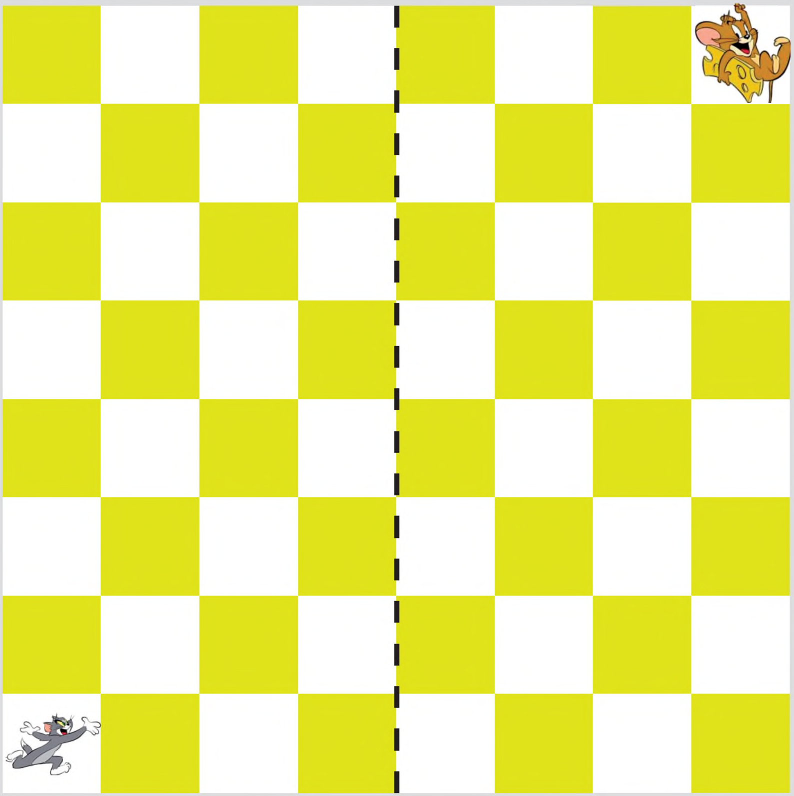
During Standard test 1 and 2 (cf. Table 5.1), the meaning of the keys was exactly the same as in the practice sessions. These tests were intended to check whether all participants had learned in all conditions.

Transfer test 1 and 2 tapped the extent to which participants could use the knowledge and skills they learned during the practice sessions in a somewhat different environment. These tests thus measured whether participants had learned *new* things. To this aim, the Tom and Jerry task contained a hidden structure: During all trials, *a midline* (invisible to the participants) divided the screen into a left and a right part. The keys took on a different meaning on the left and the right part of the screen (Figure 5.1). This hidden structure did not change across the practice and test trials. However, the mapping of the key functions (the meaning of the keys at the left and at the right screen parts) was reversed in the two transfer tests. For instance, the key '4' meant 'move upwards' in the *left* part of the screen during all previous trials, but during both transfer tests this key would move Tom upwards in the *right* part of the screen.

Figure 5.1: Starting screen of the Tom & Jerry task, including an explanation of the hidden structure

Mapping of the keys at the left part of the screen during the Baseline test, Practice session 1 & 2 and Standard test 1 & 2:
1: Tom moves downwards
2: Tom moves to the left
3: Tom moves to the right
4: Tom moves upwards

Mapping of the keys at the right part of the screen during the Baseline test, Practice session 1 & 2 and Standard test 1 & 2:
1: Tom moves upwards
2: Tom moves downwards
3: Tom moves to the left
4: Tom moves to the right



Mapping of the keys at the left part of the screen during Transfer test 1 & 2:
1: Tom moves upwards
2: Tom moves downwards
3: Tom moves to the left
4: Tom moves to the right

Mapping of the keys at the right part of the screen during Transfer test 1 & 2:
1: Tom moves downwards
2: Tom moves to the left
3: Tom moves to the right
4: Tom moves upwards

Hidden midline

Autonomy manipulation. The task autonomy manipulation was based on Hackman and Oldham's (1975) definition of autonomy and on the error management literature (e.g., Frese et al., 1991; Heimbeck et al., 2003), where the strictness of the instructions and the opportunities to make mistakes were varied experimentally. In the *no autonomy* condition, participants received precise instructions during the practice sessions concerning the most efficient way to reach Jerry: Prior to each keystroke, the key they had to use appeared on the screen. Moreover, since all other keys were locked, participants could not explore alternative ways to reach Jerry. Thus, they learned the single best way to reach Jerry (which was only useful during the practice and standard tests). In the *moderate autonomy* condition, participants received the same instructions during the practice sessions as in the no autonomy condition. However, all keys were unlocked. Participants thus had the opportunity to make mistakes and to explore other routes to reach Jerry. Finally, participants in the *full autonomy* condition did not receive any instructions during the practice sessions concerning the keys they should use, and all keys were unlocked. In effect these participants had full freedom and discretion to make decisions, to explore, to discover the key functions and to learn the most efficient route to Jerry. This manipulation was shown to be effective in a prior study using the same paradigm (Wielenga-Meijer et al., in press).

Interruption manipulation. Participants were frequently interrupted during all ten practice trials of the Tom and Jerry practice sessions, in order to investigate the effects of cognitively (un)demanding interruptions. In order to prevent the participants from anticipating on the interruptions, we 1) randomized the timing of the interruptions, ranging from every third to every fifth keystroke used to move Tom, and 2) randomized the number of interruptions from two to four. For the interruptions we used items of the three versions of the Raven IQ test, i.e., the Standard Progressive Matrices (Raven, Raven & Court, 1958), the Coloured Progressive Matrices (Raven, Raven & Court, 1956) and the Advanced Progressive Matrices (Raven, Raven & Court, 1976). These items appeal to visuo-spatial memory, as does the Tom and Jerry task, making these interruptions stronger as they draw on the same cognitive resources as the main task does (Gillie & Broadbent, 1989). Based on a pilot study in which participants had to solve the items from all three versions of the Raven tests, we categorized 40 items as cognitively undemanding and another 40 as demanding.

Participants in both interruption conditions were given 15 seconds for each 'puzzle' to solve (pilot studies had shown that this was sufficient to solve the demanding items). After 15 seconds, or when the participant pressed a key as an answer on the puzzle, the Tom and Jerry task popped up again. Puzzles that were answered within 1 second (7% of all puzzles) were considered as missing values, since most of these (86%) were answered incorrectly (even the very easy ones) and had probably not been noticed by the participants. The amount of unnoticed interruptions was independent of the cognitive demandingness condition. From all puzzles that needed at least 1 second to be solved, 77% was answered correctly, showing that the participants took this secondary task seriously.

Measurements

The variables tapping motivation (i.e., task pleasure and motivation to learn) and perceived mental load of the interruptions were measured directly after Standard test 2 and before Transfer test 1 (Table 5.1). Therefore, the scores on these measures could not be affected by the transfer tests. The questionnaires for personal initiative and need for cognition (covariates) were conducted directly after Transfer test 2.

Learning outcome. Transfer tests 1 and 2 reflected participants' performance in a new environment, signifying the extent to which participants had learned new things and were able to transfer the knowledge they had acquired. The number of keystrokes used during these tests (the less keystrokes the better) is our operationalization of learning.

Motivation. Two aspects of motivation were measured: task pleasure and motivation to learn. *Task pleasure* was measured with two items ("I enjoyed the Tom and Jerry practice trials" and "I enjoyed the Tom and Jerry tests": 1 = *strongly disagree*, 5 = *strongly agree*, Cronbach's $\alpha = .81$). *Motivation to learn* was measured with three items ("I was motivated to ...", 1) "... discover the meaning of the keys during the Tom and Jerry practice trials", 2)"... master the Tom and Jerry game", and 3) "... learn in the Tom and Jerry game"), Cronbach's $\alpha = .90$. Factor analysis of all five items measuring motivation revealed the expected two-factor structure, supporting the distinction between both variables.

Manipulation check interruptions. Three measures were used to check the validity of the interruption manipulation. First, a two-item questionnaire was provided, measuring *perceived mental load* (i.e., difficulty and complexity) of the interruptions (e.g., "How simple/complex were the puzzles you had to solve?", 1 = *very simple*, 4 = *very complex*, Cronbach's $\alpha = .92$). Furthermore, two performance measures were used as objective measures: The *percentage* of correctly solved puzzles and the average *time* in seconds, needed to solve the puzzles.

Personal initiative. This concept was measured using the seven-item scale developed by Frese et al. (1997). A typical item of this scale is "When something goes wrong, I look immediately for a solution" (1 = *never,* 5 = *always,* $\alpha = .74$).

Need for Cognition. We used a Dutch version of Cacioppo and Petty's (1982) 18-item Need for Cognition scale. An example item is "I really enjoy a task that involves coming up with new solutions to problems." (1 = *strongly disagree*, 7 = *strongly agree*, $\alpha = .81$).

5.3 Results

Based on preliminary analyses, we discarded the data from 13 participants with extremely poor scores (higher than 2 *SD*s above the mean) on one of the four performance tests (i.e., the standard or the transfer tests), because these unlikely scores could signify lack of understanding of the task (Bobko, 1995; Roth & Switzer, 2002). Furthermore, we eliminated one participant that missed more than half of all the interruptions he was exposed to. Further analyses were based on a sample of 119 participants.

Manipulation checks

In order to check for *pre-manipulation differences*, a 3 x 2 ANOVA was conducted with task autonomy and cognitive demands as independent variables and the pre-manipulation baseline test scores as the dependent variable. The results revealed no differences among the groups, $Fs < 1$, indicating that all participants initially performed equally well.

5

To check the *cognitive demands manipulation*, three 3 x 2 ANOVAs were conducted with autonomy and cognitive demands as the independent variables and perceived mental load and both measures of performance during the interruptions (% of correct answers and time needed to solve the interruptions) as the dependent variables. These results only showed a main effect for cognitive demands, indicating that the autonomy manipulation did not affect these measures of demandingness. As expected, the demanding interruptions were perceived as more difficult or complex ($M_{demanding} = 2.95$, $SD_{demanding} = 0.70$) than the undemanding interruptions ($M_{undemanding} = 1.54$, $SD_{undemanding} = 0.51$), $F(1,113) = 149.39$, $p < .001$, $\eta^2 = .57$. Furthermore, performance on the demanding interruptions was worse ($M_{demanding}$ = 60% correct answers, $SD_{demanding} = 18.07$)

than that on the undemanding interruptions ($M_{undemanding}$ = 89% correct answers, $SD_{undemanding}$ = 9.53), F (1,113) = 112.21, $p < .001$, $\eta^2 = .50$, while the demanding interruptions also took longer to solve ($M_{demanding}$ = 10.63 seconds, $SD_{demanding}$ = 1.42 versus $M_{undemanding}$ = 4.17 seconds, $SD_{undemanding}$ = 1.02), F (1,113) = 773.57, $p < .001$, $\eta^2 = .87$. Thus, the demanding interruptions were indeed perceived as significantly more demanding than the undemanding interruptions.

In order to investigate whether participants had learned to reach Jerry more efficiently during the learning phase, we conducted a repeated measurements analysis with performance on the Baseline test, Standard Test 1 and Standard Test 2 as within-subject variables. The results showed increasing performance over these tests ($M_{baseline\ test}$ = 43.35, $SD_{baseline\ test}$ = 27.36; $M_{Standard\ test1}$ = 22.77, $SD_{Standard\ test1}$ = 11.22; $M_{Standard\ test2}$ = 17.87, $SD_{Standard\ test2}$ = 5.06), Wilks' Lambda (2,117) = 63.82, $p < .001$, $\eta^2 = .52$, showing that during the experiment the participants became indeed better able to reach Jerry efficiently.

Hypotheses tests

Autonomy × Cognitive demands effect on transfer tests. In order to test Hypothesis 1, expecting an interaction effect of autonomy and cognitive demands on learning outcomes, two 3 (autonomy) × 2 (cognitive demands) ANCOVAs were conducted on Transfer test 1 and 2, with personal initiative and need for cognition as covariates. These analyses revealed a significant Autonomy x Cognitive demands interaction effect on task performance during Transfer test 1, F (2,111) = 3.90, $p < .05$, $\eta^2 = .07$ (see Table 5.2, and Figure 5.2), but not for Transfer test 2, F (2,111) = 1.72, *ns* (Hypothesis 1 supported for Transfer test 1, not for Transfer test 2).

Table 5.2: Univariate 3 x 2 ANCOVA for Autonomy x Cognitive Demands on the number of keystrokes for Transfer test 1

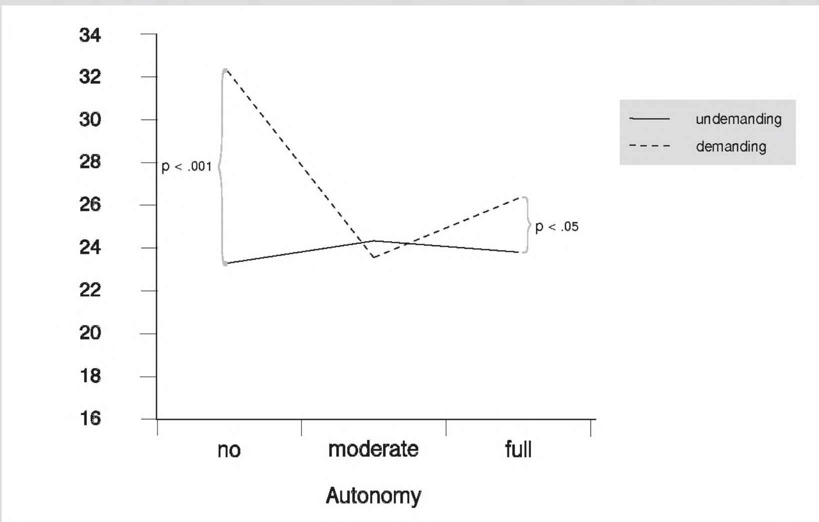
	Cognitive demandingness of interruptions					
	Undemanding		Demanding			
Autonomy	*M*	*SD*	*M*	*SD*	$F_{Autonomy\ x\ Cognitive\ Demands}$ (2,111)	η^2
No autonomy	23.39	4.62	32.00	9.42		
Moderate autonomy	24.35	10.29	23.74	6.18	3.90*	.07
Full autonomy	24.18	5.55	26.27	6.39		

Note: * $p < .05$

To investigate the predictions regarding the direction of the interaction effects (Hypotheses 1a and 1b), three separate one-tailed univariate ANCOVAs were conducted for no, moderate and full autonomy. In all analyses cognitive demands was the independent variable, Transfer test 1 the criterion variable, and personal initiative and need for cognition were included as covariates. Since these hypotheses build on Hypothesis 1, the analyses were only conducted for Transfer test 1 (not for Transfer test 2).

The results showed that in the no autonomy condition demanding interruptions caused worse performance ($M_{\text{demanding}}$ = 32.00, $SD_{\text{demanding}}$ = 9.42) than undemanding interruptions ($M_{\text{undemanding}}$ = 23.39, $SD_{\text{undemanding}}$ = 4.62), F (1, 37) = 11.88, $p < .001$, $\eta^2 = .24$. In the full autonomy condition, demanding interruptions also led to worse performance ($M_{\text{demanding}}$ = 26.27, $SD_{\text{demanding}}$ = 6.39) than undemanding interruptions ($M_{\text{undemanding}}$ = 24.18, $SD_{\text{undemanding}}$ = 5.55), F (1, 35) = 3.07, $p < .05$, $\eta^2 = .08$. For moderate autonomy the degree of cognitive demands did not influence the performance during Transfer test 1, ($M_{\text{demanding}}$ = 23.74, $SD_{\text{demanding}}$ = 6.18; $M_{\text{undemanding}}$ = 24.35, $SD_{\text{undemanding}}$ = 10.29), F (1, 35) = 0.70, *ns,* showing that the effect of the cognitive demands was smaller when participants had moderate, rather than no or full autonomy (Hypothesis 1a and 1b supported for Transfer test 1).

Figure 5.2: Interaction effect of Autonomy x Cognitive Demands on performance during Transfer test 1



Autonomy and motivation. To explain the differential effects of (un)demanding interruptions for the no versus moderate autonomy condition, we exploratively investigated whether our manipulations affected motivation, controlling for personal initiative and need for cognition. A 3 (autonomy) × 2 (cognitive demands) MANCOVA on task pleasure and motivation to learn showed an overall significant effect of autonomy, Wilks' Lambda, F (4, 220) = 5.04, p < .01, η^2 = .08. No other effects were significant. Further, two univariate two-tailed ANCOVAs, for the two measures of motivation as dependent variables and autonomy as independent variable, showed a main effect for autonomy on task pleasure, F (2, 111) = 6.00, p < .01, η^2 = .10, as well as motivation to learn, F (2, 111) = 4.55, p < .05, η^2 = .08 (see Table 5.3).

Table 5.3: Univariate ANCOVA for three levels of autonomy on task pleasure and motivation to learn

Variable	Autonomy	*N*	Range	*M*	*SD*	*F* (2,111)	η^2
Task pleasure	No autonomy	41	1 - 5	2.55_a	1.11	6.00**	.10
	Moderate autonomy	39	1 - 5	3.17_b	0.81		
	Full autonomy	39	1 - 5	3.35_b	1.14		
Motivation to learn	No autonomy	41	1 - 5	3.88_a	0.83	4.55*	.08
	Moderate autonomy	39	1 - 5	3.76_a	0.86		
	Full autonomy	39	1 - 5	4.20_b	0.79		

Note: Different subscripts indicate significant differences between the conditions in LSD post hoc analyses
* p < .05, ** p < .01.

LSD post hoc analyses on task pleasure revealed that having no autonomy decreased task pleasure (M_{no} = 2.55, SD_{no} = 1.11) compared to both (moderate and full) autonomy conditions ($M_{moderate}$ = 3.17, $SD_{moderate}$ = 0.81; M_{full} = 3.35, SD_{full} = 1.14). Regarding motivation to learn, LSD post hoc tests showed that having no or moderate autonomy caused lower motivation to learn the Tom and Jerry task (M_{no} = 3.88, SD_{no} = 0.83; $M_{moderate}$ = 3.76, $SD_{moderate}$ = 0.86) than having full autonomy (M_{full} = 4.20, SD_{full} = 0.79).

5.4 Discussion

This study aimed to obtain more insight into the relationship between autonomy and learning outcomes. Previous studies showed inconsistent findings regarding this relationship (Spector, 1986; Steward, 2006, Wielenga-Meijer et al., 2010), which may be explained by assuming that the degree of autonomy is curvilinearly associated with learning outcomes (Warr, 2007; Wielenga-Meijer et al., in press). We assumed that having full autonomy while learning would require more expenditure of cognitive resources than having moderate levels of autonomy. In the present study, this assumption was investigated experimentally by manipulating the cognitive resources available during learning: The learning task was interrupted by cognitively demanding (i.e., few cognitive resources available for learning) or undemanding tasks (i.e., many cognitive resources available for learning).

Autonomy, cognitive demands and learning outcomes. As expected, this study revealed that when learning a task that is interrupted by cognitively demanding tasks, learning outcomes decreased when having full autonomy, while the adverse effects of high cognitive demands were absent in the moderate autonomy condition (Hypothesis 1a). This supports Trudel and Payne's (1995) reasoning that having full autonomy causes inefficient behaviour (including less efficient exploration behaviour), because this condition requires more expenditure of cognitive resources than having moderate autonomy. We found a similar pattern for the effects of (un)demanding interruptions in the no versus moderate autonomy conditions. In the no autonomy condition, experiencing demanding interruptions caused significantly worse learning outcomes than undemanding interruptions, while the manipulation of cognitive demands did not affect the moderate autonomy condition (Hypothesis 1b).

The role of motivation. This curvilinear relationship between task autonomy and learning outcomes may partly be accounted for by motivational processes. The present study included motivation to learn and task pleasure as measures of motivation. Full autonomy was beneficial for the motivation to learn the Tom and Jerry task, as compared to having no and moderate autonomy. This suggests that full autonomy did not only *necessitate* the participants to spend more effort on the task; it also *motivated* them to spend more effort. Thus, whereas participants were usually willing to learn, the cognitively demanding task interruptions made it difficult for them to realize their aspirations in this respect.

Having no autonomy resulted in lower levels of task pleasure than having moderate or full autonomy. This finding, in combination with the adverse learning outcomes in the cognitively demanding interruption condition when having no autonomy, supports the proposition that task pleasure is an essential condition for learning (cf. McCombs & Whisler, 1989; Ridley, 1991). In a general sense, the participants in the present study were motivated to learn the Tom and Jerry task (Table 5.3), but in the absence of autonomy they did not enjoy the Tom and Jerry task sufficiently to invest the effort needed to learn the task. In the no autonomy/undemanding interruption condition, the participants were able to keep up performance in spite of the fact that they did not like the task. However, when the task was interrupted by cognitively demanding interruptions, learning outcomes decreased, suggesting the participants were both unable and unwilling to spend the required effort.

Moderate levels of autonomy are motivating and efficient. Interestingly, the manipulation of the cognitive demandingness of the interruptions did not affect learning outcomes in the moderate autonomy condition. This may be due to the fact that participants having moderate levels of autonomy showed significantly more pleasure in learning the Tom and Jerry task than participants in the no autonomy condition, suggesting that they enjoyed the learning task well enough to put the required effort into the task -- even if they experienced cognitively demanding interruptions. Moreover, because these participants received guidance during the learning task, their learning behaviour may have been more focused and they may have had some ‘buffer capacity’ that allowed them to deal with the cognitively demanding interruptions. Overall, moderate levels of autonomy are most beneficial compared to having no or full autonomy, because this condition enhances motivation and promotes efficient learning behaviour (cf. Wielenga-Meijer et al., in press).

Effects over time. We found that autonomy was associated with learning for the first transfer test, but not for the second test. This suggests that participants may have been learning during Transfer test 1 as well, resulting in equal performance across all conditions on Transfer test 2. For full autonomy, these results confirm prior studies showing that having ‘too much’ (i.e., full) autonomy leads to similar learning outcomes as moderate levels of autonomy (Trudel & Payne, 1995; Wielenga-Meijer et al., in press), although learning in this condition requires more practicing to reach the same level of performance. Thus, given enough time, the learning outcomes in the full autonomy environment may ultimately be the same as those obtained in an environment providing more guidance, but the learning process itself is less efficient. Future research should attempt to obtain more insight into the long-term effects of autonomy in combination with task interruptions.

Study limitations

The most important limitations of the present study are the following. First, autonomy was treated as a unidimensional variable. However, actually *two* aspects of autonomy were manipulated, namely the opportunities to explore freely (by (un-)locking particular keyboard keys) and the amount of information provided about the task to be conducted (the instructions). The effects of both aspects of autonomy were studied jointly, meaning that no insight was obtained in whether they could possibly affect learning differentially. Follow-up studies may study these aspects separately to obtain more insight into their possibly distinct effects on learning.

Furthermore, in our study we differentiated among three levels of autonomy (having no, moderate versus full autonomy). Our findings suggest that these levels correspond with having 'too little', 'sufficient' and 'too much' autonomy. However, there are no well-established cut-off points that separate having too little or too much autonomy from having sufficient autonomy. Moreover, whether a particular level of autonomy is sufficient, too little or too much will also depend on the task to be conducted as well as on other factors, including the degree to which the task is interrupted. Therefore, in practice criteria will need to be developed and tested for a variety of settings, examining which level of autonomy is adequate given the specific setting and the tasks at hand.

Finally, transient differences in coping capacities, for example due to fatigue, may also play a role in the relationship between autonomy and learning outcomes. For example, Van der Linden, Frese and Sonnentag (2003) found that mental fatigue decreased learners' exploration and learning behaviour when they had to learn a complex computer task. In the same line, the relationship between autonomy and learning outcomes may be moderated by personal circumstances like fatigue.

Practical implications and conclusions

In spite of these limitations, the present study enhances current research on task autonomy and learning outcomes in at least two respects. Most importantly, the present study provides a novel look at the relationship between autonomy and learning outcomes. Previous research has almost consistently conceptualized this relationship to be linear, in spite of the fact that earlier reviews have provided mixed evidence for this assumption (Spector, 1986; Steward, 2006; Wielenga-Meijer et al., 2010). In contrast, the present study assumed that this relationship is curvilinear, in that having too much autonomy could lead to adverse learning outcomes. Our findings supported this assumption, underlining the need for a reconceptualization of the relationship between autonomy and learning outcomes: More is not always better.

Second, the addition of interruptions during the learning process strongly improves the ecological validity of the experimental design, relative to other studies that have examined the relationship between autonomy and learning outcomes experimentally. Learning is not a continuous, uninterrupted process, and will often be interrupted in numerous ways, for instance. It will be interrupted by incoming email messages, telephone calls or colleagues, neighbours, family or friends coming by (Jackson, Dawson & Wilson, 2001; Zijlstra et al., 1999). Thus, it is imperative for studies on learning behaviour to take such interruptions into account. This also applies to more naturalistic, non-experimental approaches to studying learning; here, too, is learning often studied without considering possible interruptions. In this sense the present study underlines the importance of taking such interruptions into account.

All in all, autonomy is an important antecedent of learning outcomes, since it motivates and provides the opportunities to explore. However, having too much of a good thing (autonomy) may lead to adverse learning outcomes when cognitive demands are high. We recommend that in order to facilitate learning a new task, learners should have opportunities to explore new ways of doing their task as well as receive sufficient guidance to facilitate the learning process. Moreover, care should be taken that the interruptions that will unavoidably occur do not impose strong demands upon the learners' cognitive resources, as otherwise the learning process will take much longer than is needed. Without the presence of *both* factors (sufficient autonomy and sufficient cognitive resources), learners may be either unmotivated or unable to learn the task.

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Chapter 6

General discussion

6

We learn and grow and are transformed not so much by what we do but by why and how we do it.

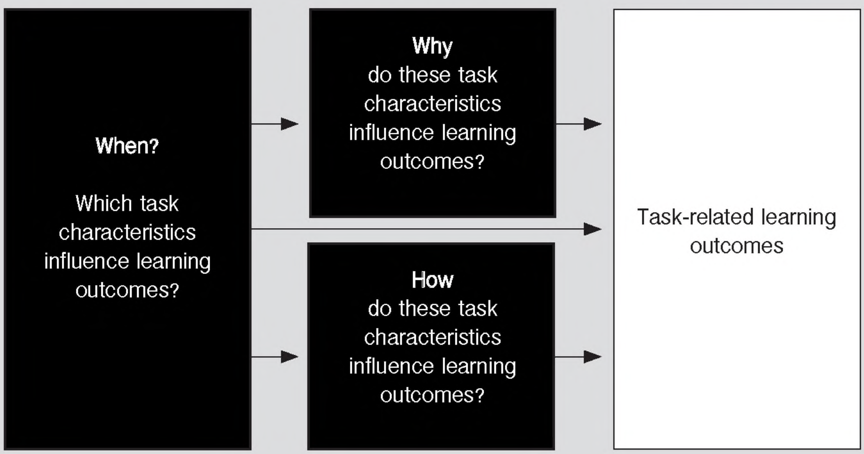
Sharon Salzberg

6.1 Introduction

This thesis was built upon the assumption that the characteristics of one's task and task-related learning outcomes are related. Although many theoretical perspectives presume that task-related learning outcomes depend partly on task characteristics (Taris & Kompier, 2005), the findings regarding this relationship and the psychological processes accounting for it are scattered. Therefore, the circumstances when, the reasons why, and the ways how task-related learning may occur, were not well understood.

This thesis aimed to enhance our understanding of task-related learning. We investigated which task-related circumstances are beneficial (or disadvantageous) for task-related learning outcomes (i.e., when does task-related learning occur?). Furthermore, this thesis provided a peek into the black box (e.g., the psychological processes) that may explain why and how the assumed relationship between task characteristics and task-related learning outcomes may exist, see Figure 6.1 (identical to Figure 1.1).

Figure 6.1: Visualization of the aim of this thesis: Understanding task-related learning



In Chapter 1, we introduced three research issues. The first of these examined which task characteristics and which learning processes are theoretically assumed to promote task-related learning outcomes (Issue 1). The second research issue built upon the first, examining whether empirical evidence supports the theoretically assumed relationships between task characteristics, learning processes and task-related learning outcomes (Issue 2). Based on the findings for Issue 2 we then focused on one of the antecedents of task-related learning outcomes (namely autonomy), i.e., when, why and how can the relationship between autonomy and task-related learning outcomes exist (Issue 3)?

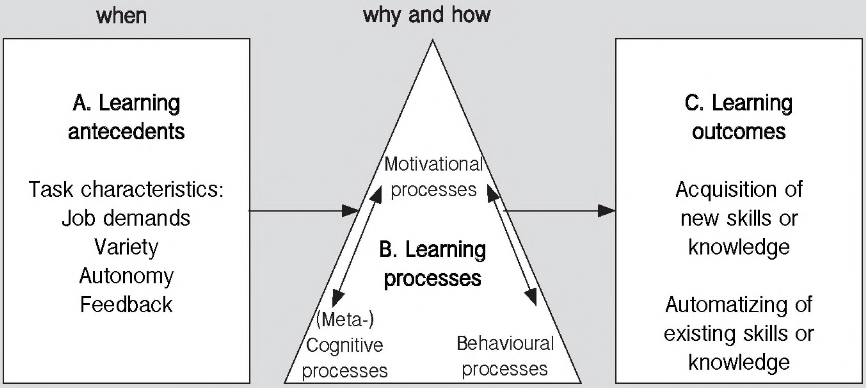
These three research issues were translated into ten specific research questions that were addressed in Chapters 2 - 5. Based on these questions, we tried to understand when, why and how task-related learning may occur. In the present chapter we briefly summarize our main results. We also discuss some related theoretical implications (§6.2). Table 6.1 presents an overview of the three issues, the ten research questions, the corresponding answers to these research questions and the theoretical implications. Furthermore, we discuss limitations (§6.3) and assets of our studies (§6.4). Next, we provide recommendations for future research on task-related learning (§6.5) and discuss the main practical implications of our findings (§6.6).

6.2 Summary of the main findings

Research issue 1: Which task characteristics and which learning processes are theoretically assumed to promote task-related learning outcomes?

In order to investigate this issue we reviewed and compared five 'grand' theories that connect task characteristics to task-related learning outcomes, focusing on the processes that propose to account for this association, namely: 1) the Job Characteristics Model (Hackman & Oldham, 1975, 1980), 2) the Demand-Control model (Karasek, 1979), 3) Action Theory (Frese & Zapf, 1994; Hacker, 1998), 4) Goal Setting Theory (Locke & Latham, 1990), and 5) Self-Determination Theory (Deci & Ryan, 1985). Based on an integration and extension of these theories, we presented a heuristic model of the causal linkages between task characteristics, learning processes and learning outcomes. Acquisition of new knowledge and skills and the improvement of existing skills were considered as task-related learning outcomes in each of these theories (Figure 6.2, identical to Figure 2.2 and 3.1).

Figure 6.2: A heuristic model for learning antecedents, learning processes and learning outcomes



We concluded that task-related learning outcomes can be increased *when* a task provides high (but not overwhelming) job demands, enough variety, autonomy and meaningful feedback (cf. *Research question 1a*). We assumed that one reason *why* this relationship could exist is that these task characteristics increase motivation (cf. *Research question 1b*). Furthermore, we proposed three ways *how* these task characteristics could influence task-related learning outcomes (cf. *Research question 1c*): Because they stimulate cognitive processes (i.e., the construction of a mental model) and meta-cognitive processes (i.e., setting (high) personal goals) as well as behavioural processes (i.e., exploration behaviour).

Theoretical implication Research issue 1. The heuristic model presented in Figure 6.2 provided the starting point for our further research on task-related learning.

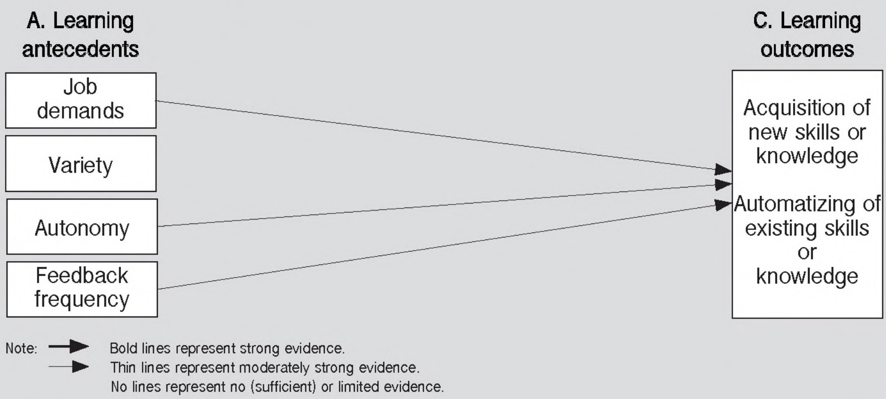
Research issue 2: Does empirical evidence support the theoretically assumed relationships between task characteristics, learning processes and task-related learning outcomes?

The model in Figure 6.2 provided theoretical answers as to the when, why and how questions of task-related learning. Chapter 3 involved a systematic literature review that was based upon 85 empirical studies, in order to investigate the empirical evidence for these relationships. In order to answer the four research questions 2a, 2b, 2c and 2d, we will now summarize the key findings, i.e., the relationships for which we found moderate or strong evidence[7]. Figures 6.3 to 6.6 visualize our key findings. Please note that bold lines represent 'strong evidence', thin lines represent 'moderately strong evidence', whereas the absence of a line represents 'no' (sufficient) or only 'limited evidence'.

[7] Evidence that would contradict our hypotheses would also be considered as a key finding. However, evidence disconfirming our hypotheses was not found.

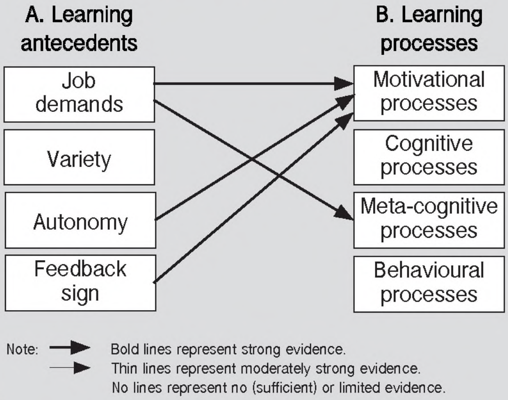
Research question 2a: How strong is the evidence for the theoretically proposed relationship between task characteristics and task-related learning outcomes? We found moderately strong evidence for positive relationships between job demands, autonomy and feedback frequency on the one hand and task-related learning outcomes on the other, which suggests that these task characteristics indeed promote task-related learning outcomes (Figure 6.3). The fact that the evidence regarding job demands as well as autonomy and task-related learning outcomes is *moderately* strong rather than strong might be due to nonlinearity. *Excessively* high demands may be 'overwhelming' (Karasek, 1998) and impede learning outcomes. This may also be the case for autonomy, as will be discussed below (Research issue 3).

Figure 6.3: Summary of the main findings for the associations between task characteristics and learning outcomes



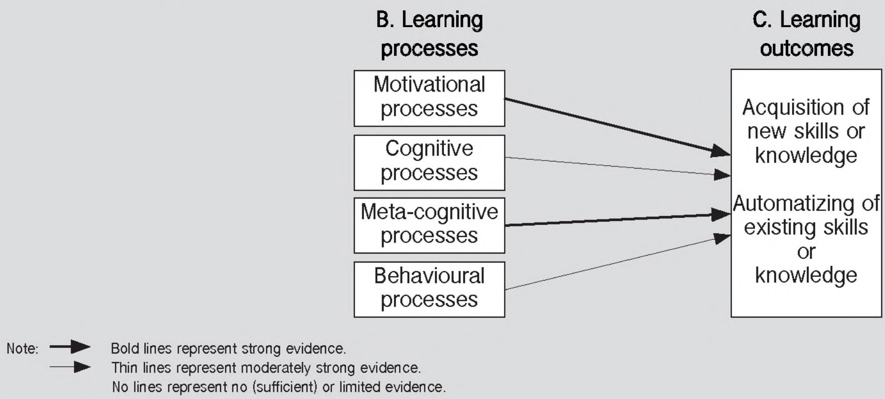
Research question 2b: How strong is the evidence for the theoretically proposed relationship between task characteristics and learning processes? Consistent with our hypotheses, strong evidence was found for positive relationships between job demands on the one hand and motivational and meta-cognitive processes (personal goal setting) on the other. Furthermore, both autonomy as well as feedback sign were positively associated with motivational processes (Figure 6.4). The findings regarding the relationship between these task characteristics and cognitive or behavioural processes were also in line with our hypotheses. However, in this case, evidence was limited because of a paucity of studies.

Figure 6.4: Summary of the main findings for the associations between task characteristics and learning processes



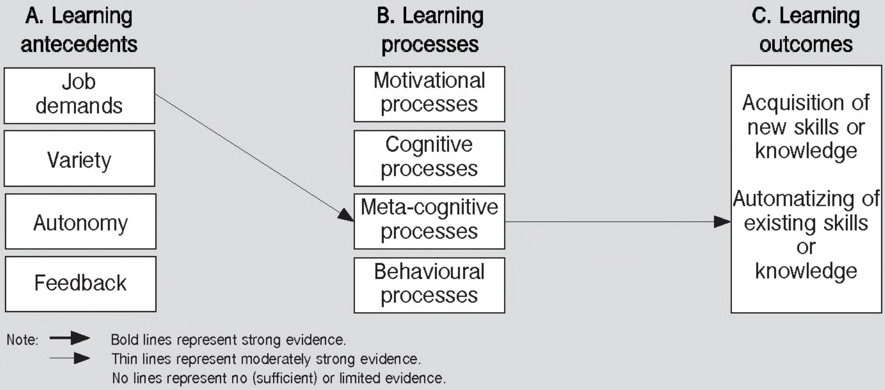
Research question 2c: How strong is the evidence for the theoretically proposed relationship between learning processes and task-related learning outcomes? In Chapter 3 we found strong evidence for positive relationships among motivational as well as meta-cognitive processes (i.e., personal goal setting) and task-related learning outcomes. Furthermore, we found moderately strong evidence for positive relationships between cognitive as well as behavioural processes and task-related learning outcomes (Figure 6.5). Our hypothesis that these processes are positively associated with task-related learning outcomes was thus supported.

Figure 6.5: Summary of the main findings for the associations between learning processes and learning outcomes



Research question 2d: How strong is the evidence for a full model including task characteristics, learning processes as mediators (explaining why and how the relationship may exist) and task-related learning outcomes? In the current literature review, we found moderately strong evidence that the relationship between job demands (i.e., goal difficulty) and task-related learning outcomes as mediated by personal goals (Figure 6.6).

Figure 6.6: The relationship between job demands and learning outcomes as mediated by meta-cognitive processes (setting higher personal goals)



Regarding the other potential mediating relationships, there was either no evidence at all or only very limited evidence available. Therefore we cannot draw firm conclusions when it comes to all of the other proposed relationships (e.g., autonomy → exploration → task-related learning outcomes or job demands → motivation → task-related learning outcomes). However, in conjunction with the supportive evidence for the bivariate underlying relationships (task characteristics – task-related learning outcomes; task characteristics – learning processes; and learning processes – task-related learning outcomes), these results lend credit to the notion that learning processes indeed account for (part of) the relationships between task characteristics and task-related learning outcomes. Furthermore, it is important to note that findings *dis*confirming our ideas were virtually absent in our selection of studies. Thus, the model presented in Figure 6.2 seems a reasonable representation of both the theoretical and the empirical relationships among learning antecedents and learning processes and task-related learning outcomes.

Theoretical implications Research issue 2. The results of the systematic review presented in Chapter 3 have two important theoretical implications. The first refers to the shape of the relations that were investigated. Karasek (1998) mentioned that job demands should not be overwhelming, as overwhelming job demands could lead to adverse learning outcomes. This is an interesting idea. Nonetheless, most studies in our literature review were not designed to examine the shape of the relationships between job demands and learning processes or outcomes. Regarding the relationship between autonomy and learning outcomes, none of the five selected theoretical approaches assumed a curvilinear relationship that would suggest adverse learning effects of 'too much' autonomy (see Chapter 2). However, the results in Chapter 3 showed contradictory evidence regarding this relationship (positive, negative as well as non significant relationships were presented), resulting in *moderately strong* rather than *strong evidence*. One explanation for these findings may be that the relationship between autonomy and learning outcomes has a curvilinear shape (Warr, 2007). Thus, it may be worthwhile to examine possible curvilinear relationships between task characteristics and learning outcomes.

The second theoretical implication draws upon the fact that studies 'testing' the full heuristic model were sparse. From the 85 studies included in our review, only 11 studies investigated whether learning processes mediate the relationship between task characteristics and task-related learning outcomes. Although these studies provided some evidence for the idea that the relationship between task characteristics and learning outcomes is mediated through motivational, meta-cognitive, cognitive and behavioural processes, there is a clear need for more research into this issue.

Research issue 3: When, why and how can the relationship between autonomy and task-related learning outcomes exist?
After the more general study of task characteristics, learning processes and learning outcomes in Chapter 2 and 3, we concentrated on the characteristic of autonomy in the following two chapters. Based on Chapter 3, we proposed that the positive relationship between autonomy and task-related learning outcomes (such as improved task performance) only holds up until a certain optimum level of autonomy has been reached. In an experimental study (Chapter 4), this 'curvilinearity' hypothesis was tested (*Research question 3a)*. Task performance on a so-called transfer test (which represented the extent to which participants could use the knowledge and skills they learned previously in a somewhat different environment) was our operationalization of task-related learning outcomes. In Chapter 5 we extended this research question in another experimental study, in which we examined why the relationship between autonomy and task-related learning outcomes is curvilinear instead of linear (*Research question 3b*). Particularly, we examined whether the relationship between autonomy and task-related learning outcomes varied under different

levels of cognitive demanding interruptions. In Chapter 4 we also dealt with *Research question 3c*, i.e., which learning processes account for the relationship between autonomy and task-related learning outcomes.

Research question 3a: Is the relationship between autonomy and task-related learning outcomes curvilinear? Our studies (Chapters 4 and 5) indeed showed a curvilinear relationship between autonomy and task-related learning outcomes. Our study in Chapter 4 showed that (moderate and full) autonomy was beneficial compared to no autonomy at all. Autonomy caused increased levels of motivation to learn the task, exploration behaviour and task-related learning outcomes. However, moderate autonomy was beneficial compared to full (i.e., 'too much') autonomy. We found that full autonomy did not result in higher levels of motivation to learn, nor did it result in better learning outcomes when compared to moderate autonomy. We also found that in the full autonomy condition more exploration behaviour was needed to reach the same task-related learning outcomes as compared to the moderate autonomy condition, and that performance in the full autonomy condition was worse in a test situation which was identical to the learning phase, as compared to moderate autonomy.

Note that whereas these curvilinear learning outcomes were obtained in the *second* transfer test in Chapter 4, they were found in the *first* transfer test in the study presented in Chapter 5. It seems that the study in Chapter 5 cannot be seen as a simple replication of the study in Chapter 4. A key difference between both studies is the presence of interruptions in the Chapter 5 study (versus the absence of interruptions in the Chapter 4 study). Because of these interruptions, much more time had passed when the participants started the first transfer test in Chapter 5 (M = 11.9 minutes) as compared to the time that had passed when participants started the first transfer test (the warning test) in Chapter 4 (M = 4.5 minutes). Future studies should investigate whether the presence of the interruptions (and possible unconscious learning processes that occur while the participants conduct the interrupting tasks) may explain the different results.

Research question 3b: Why is the relationship between autonomy and task-related learning outcomes curvilinear instead of linear? Our Chapter 5 experiment showed that the influence of autonomy on task-related learning outcomes varied between cognitively undemanding versus cognitively demanding interruptions. We found that when learning a new task that is interrupted by cognitively demanding tasks, learning outcomes decrease when having full autonomy. Such adverse effects of cognitively demanding interruptions were absent when having moderate levels of autonomy. These findings suggest that when learning a new task and given full autonomy, the learning process requires more expenditure of cognitive resources than when moderate levels of autonomy are provided. These findings also support Trudel and Payne's (1995) idea that having too much autonomy causes inefficient (exploration) behaviour. Based on these findings, we thus believe that the adverse effects of autonomy on learning outcomes can be explained by the relatively high cognitively demanding character of full autonomy.

Furthermore, the presence of cognitively demanding interruptions also decreased learning outcomes when no autonomy was provided when learning a task. We propose that these moderating effects may be due to motivational factors, as discussed below.

Research question 3c: Which learning processes (explaining why and how the relationship may exist) account for the relationship between autonomy and task-related learning outcomes? In Chapter 4 we investigated the effect of autonomy on motivation to learn as well as on exploration behaviour. This study thus peeks into the black box of learning processes, as it considers the questions *why* and *how* the relationship between autonomy and task-related learning outcomes may exist. The results revealed that motivation to learn and perceived exploration behaviour jointly mediated the positive influence of autonomy (versus no autonomy) on task-related learning outcomes. It thus seems that the beneficial effects of autonomy on learning outcomes can be explained by motivation to learn and exploration behaviour.

In Chapter 5, we not only measured the effect of autonomy on motivation to learn, but also the influence of autonomy on *task pleasure*. Please note that in Chapter 4 and 5, high motivation to learn could be driven by reasons such as being motivated to reach an optimal score in order to win the book token awarded to the participant with the highest score, while task pleasure (Chapter 5) reflects participants' enjoyment of the task. Therefore, the latter measure reflects intrinsic motivation (Harackiewicz & Elliot, 1993). We found that participants in the full and moderate autonomy condition showed more task pleasure than participants in the no autonomy condition. Thus, in the no autonomy/ undemanding interruption condition, participants could keep up performance in spite of the fact that they did not enjoy the task. When the task was interrupted by cognitively demanding interruptions, learning outcomes decreased. This suggests that participants were both unable and unwilling to spend the required effort. These results are in line with prior findings that lack of autonomy can be frustrating (Eichar, Norland, Brady & Fortinsky, 1991; Larsen, 2005), and support the idea that task pleasure is an essential condition for learning (McCombs & Whisler, 1989; Ridley, 1991).

Considering the variable motivation to learn, it is noteworthy that the study in Chapter 5 showed a pattern different from the results in Chapter 4. Chapter 5 showed that full autonomy caused higher motivation to learn than no and moderate autonomy, while in Chapter 4, full *and* moderate autonomy resulted in higher levels of motivation to learn than no autonomy. These findings may suggest that the effects of autonomy on motivation to learn could have been influenced by the presence of interruptions. However, because the studies in Chapter 4 and 5 were conducted with different samples, in this respect firm conclusions cannot be drawn. Follow-up studies are needed to investigate to what extent the presence of interruptions affects the relationship between autonomy and the motivation to learn.

Theoretical implications Research issue 3. Our experimental studies (Chapter 4 and 5) enhanced our understanding of the relationship between autonomy and task-related learning outcomes. First of all, we found evidence that the relationship between autonomy and task-related learning outcomes should not be treated as a linear relationship; providing learners with 'too much' autonomy may not have additional benefits over provision of 'sufficient' levels of autonomy (Chapter 4). This is an important finding, as most theories (see Chapter 2) and empirical studies (see Chapter 3) assume that this relationship is linear. Secondly, we found that too much autonomy leads to adverse learning outcomes when the learning task is interrupted by cognitively demanding tasks (Chapter 5). This result suggests that full autonomy requires more expenditure of cognitive resources than moderate levels of autonomy. This seems to provide an answer to the question why too much of autonomy may lead to non-additional, or even adverse learning outcomes. This finding underlines Warr's (2007) assumption that "unremitting control [i.e., 'too much autonomy'] ... can give rise to overload problems as very high demands exceed personal capabilities" (p. 97). Thirdly, we found that the positive effects of autonomy can be explained by increased levels of motivation to learn and perceived exploration behaviour (Chapter 4). This finding provides a peek into the black box considering the relationship between autonomy and task-related learning outcomes. It explains a reason why (because of increased motivation to learn), and a way how (by means of increased levels of perceived exploration behaviour) this relationship may exist.

Table 6.1: Summary of research issues, research questions deduced from these issues, answers to the research questions and theoretical implications

Research Issues	Research questions	Answers to the research questions	Theoretical implications
Research issue 1 Which task characteristics and which learning processes are theoretically assumed to promote task-related learning outcomes?	*Research question 1a* *When* should learning occur (i.e., which task characteristics are theoretically presumed to affect task-related learning outcomes)?	Job demands Variety Autonomy Feedback	This study resulted in a heuristic model that provides insight into the black box of intrapersonal processes, accounting for the (why and how of the) relationship between task characteristics and task-related learning outcomes.
	Research question 1b Which learning processes theoretically explain *why* these task characteristics are presumed to influence task-related learning outcomes?	These task characteristics increase (intrinsic) motivation	
	Research question 1c Which learning processes theoretically explain *how* these task characteristics are presumed to influence task-related learning outcomes?	These task characteristics increase the construction of a valid mental model, are beneficial for (increasing) personal goals and stimulate exploration behaviour.	

Table 6.1: Continued

Research Issues	Research questions	Answers to the research questions	Theoretical implications
Research issue 2 Does empirical evidence support the theoretically assumed relationships between task characteristics, learning processes and task-related learning outcomes?	*Research question 2a* How strong is the evidence for the theoretically proposed relationship between task characteristics and task-related learning outcomes?	Moderately strong evidence was found for a positive relationship between: job demands - task-related learning outcomes; autonomy - task-related learning outcomes.	
	Research question 2b How strong is the evidence for the theoretically proposed relationship between task characteristics and learning processes?	Strong evidence was found for a positive relationship between: job demands - motivation; job demands - personal goals; autonomy - motivation; feedback sign - motivation.	The moderately strong relationships (job demands – learning outcomes and autonomy – learning outcomes) may suggest that both relationships are curvilinear instead of linear.
	Research question 2c How strong is the evidence for the theoretically proposed relationship between learning processes and task-related learning outcomes?	Strong evidence was found for positive relationships between: motivation - learning outcomes; personal goals - learning outcomes. Moderately strong evidence was found for postive relationships between: mental model - learning outcomes; exploration behaviour - learning outcomes.	The relationship among job demands (goal difficulty) and learning outcomes is mediated by personal goals.
	Research question 2d How strong is the evidence for a full model including task characteristics, learning processes as mediators (explaining *why* and *how* the relationship may exist) and task-related learning outcomes?	Moderately strong evidence was found for the relationship between job demand (goal difficulty) and learning outcomes was mediated by setting personal goals.	

Table 6.1: Continued

Research Issues	Research questions
Research issue 3 When, why and how can the relationship between autonomy and learning outcomes exist?	*Research question 3a* Is the relationship between autonomy and task-related learning outcomes curvilinear? *Research question 3b* Why is the relationship between autonomy and task-related learning outcomes curvilinear instead of linear? *Research question 3c* Which learning processes (explaining why and how the relationship may exist) account for the relationship between autonomy and task-related learning outcomes?

Answers to the research questions	Theoretical implications
Yes. Autonomy is beneficial compared to no autonomy. However, full autonomy leads to similar levels of motivation to learn and learning outcomes as moderate autonomy. On the other hand, full autonomy is disadvantageous for efficient learning behaviour, since more exploration behaviour is needed to reach a similar level of learning outcomes, as compared to moderate autonomy.	The relationship between autonomy and learning outcomes is curvilinear. Too much autonomy may even harm the learning processes.
No as well as full autonomy showed to be sensitive for cognitively demanding interruptions. Both conditions showed decreased learning outcomes when the learning task was interrupted by cognitively demanding tasks as compared with cognitively undemanding tasks. These differences were absent in the moderate autonomy condition.	The relationship between autonomy and learning outcomes also depends on other factors such as (cognitively demandingness of) interruptions, suggesting that very much autonomy requires more expenditure of cognitive resources than having moderate levels of autonomy.
Motivation to learn and perceived exploration jointly mediated the effects of autonomy (versus no autonomy) on learning outcomes.	The beneficial effects of autonomy on learning outcomes can be explained by motivation to learn and exploration behaviour.

6.3 Limitations of this thesis

We believe that there are two main limitations of this thesis. These relate to 1) the conceptualization of the variables and 2) the external validity of the experimental studies.

Conceptualization of the variables

Firstly, our theoretical and our empirical review (Chapter 2 and 3) were based on broad conceptualizations of its key concepts. Although this fitted our aim of mapping the various theoretical approaches and the available evidence in a broad perspective for the relationships, it also resulted in the inclusion of many different measures of our core constructs. The differences among these measures might endanger their validity, since these measures could represent different underlying constructs and processes. Specifically, we treated autonomy as a unidimensional variable (Chapter 4 and 5). However, actually *two* aspects of autonomy were manipulated: 1) the opportunities to explore freely (by (un-) locking particular keyboard keys), and 2) the amount of information provided about the task to be conducted (the instructions). As the effects of both aspects of autonomy were studied jointly, we cannot exclude the possibility that these aspects affect task-related learning outcomes differentially. Follow-up studies may examine both aspects separately to obtain more insight into their potential distinct effects on task-related learning outcomes.

Furthermore, in our two experiments (Chapter 4 and 5) we differentiated among three levels of autonomy (having no, moderate versus full autonomy). Our empirical findings suggest that these levels correspond with having 'too little', 'sufficient' and 'too much' autonomy. However, there are no well-established cut-off points that separate having 'too little' or 'too much' autonomy from having 'sufficient' autonomy. Whether a particular level of task autonomy is sufficient, too little or too much will also depend on the (complexity of the) task at hand, as well as on other contextual factors, including the degree to which the task is interrupted. Therefore, in applied settings, criteria need to be developed and tested for a variety of task contexts, the questions being which level of autonomy is adequate given the specific setting and the tasks that are being mastered.

External validity

In our experimental studies into the relationship between autonomy and task-related learning outcomes (Chapter 4 and 5), we used student populations. They had to learn a relatively simple task. Whereas this approach allowed us to examine the effects of varying amounts of autonomy on task-related learning outcomes in a carefully controlled setting, the external validity of these studies is relatively low. There are at least three ways in which this experimental design could differ from a more naturalistic setting.

Firstly, our population was homogeneous regarding their age and level of education (i.e., undergraduate university students). However, in 'real' work organizations age as well as level of education will usually differ widely among employees. As age as well as education level may influence learning processes and outcomes (Freudenthal 2001), it would be interesting to differentiate between age categories as well as level of education in follow-up studies in a more naturalistic setting.

Secondly, the participants in our experimental studies received an incentive (money or credits) for their voluntary participation. Furthermore, we promised a book token for the best performer in order to motivate participants. These rewards may have served as extra (external) motivators (Donovan, 2001; Mitchell & Daniel, 2003). Follow-up studies in a more naturalistic setting may also investigate the influence of autonomy (or other task characteristics) on task-related learning outcomes, independently of extra (external) motivators.

Thirdly, the participants in our experiments had to learn a relatively simple task. In a more naturalistic setting, the complexity of new tasks that have to be learned may differ enormously, i.e., from very simple tasks (e.g., simple data entry) to very complex tasks (e.g., air traffic control). It is conceivable that more complex tasks require more guidance than simple tasks. Therefore, we recommend that the influence of autonomy on task-related learning outcomes should be examined for different levels of task complexity.

6.4 Assets of this thesis

Notwithstanding these limitations, we believe that this thesis contributes to previous research into the relationship between task characteristics and task-related learning outcomes. We think that there are three assets. The first asset is the development of an extensive theoretical framework, including a theoretical review (Chapter 2) and a review of empirical evidence (Chapter 3). The second asset, we believe, is the more fine-grained and focused experimental approach in Chapter 4 and 5. The combination of different research approaches (a theoretical review, a literature review and experimental studies) can be considered a third asset.

Extensive theoretical framework: Theoretical review and review of empirical evidence

We reviewed, compared and integrated five 'grand' theories in order to enhance our understanding of the theoretically assumed relationships among task characteristics, learning processes and task-related learning outcomes. We combined these theoretical approaches in a heuristic model (Chapter 2) that proved very useful when it was tested empirically in Chapter 3. That chapter reviewed a large number of empirical studies (n = 85) that originated from different fields, varied regarding their study design (e.g., field studies and (quasi-) experimental studies), and were published across a large time span (over 40 years).

Focused investigation: Understanding the relationship between autonomy and task-related learning outcomes

Based on these theoretical as well as empirical reviews (Chapter 2 and 3) we concentrated on one of the proposed relationships, namely that between autonomy and task-related learning outcomes (Chapter 4 and 5). Although it is usually assumed that this relationship is linear, we found evidence that the relationship between autonomy and task-related learning outcomes is curvilinear (Chapter 4). This is consistent with Warr's (2007) assumption that having too much autonomy when learning a task can lead to overload problems (cf. Chapter 5). Related to this, in our experimental studies (Chapter 4 and 5) we examined one of the gaps in current knowledge (Chapter 3): i.e., the questions why and how autonomy may influence task-related learning outcomes. We found that autonomy positively influences task-related learning outcomes because it increases motivation to learn and stimulates exploration behaviour.

Multi-method approach

The fact that this thesis utilizes a variety of methods (i.e., a review of theory, a review of empirical studies, as well as two experimental studies) can also be considered an asset of this thesis. Furthermore, it is noteworthy that we introduced a newly developed standardized index of convergence in Chapter 3 (SIC). This index is a simple way to quantify the cumulative evidence in a literature review when a meta-analysis based upon effect sizes is not possible or less suitable, given the properties of the effect sizes to be combined and the analyses upon which these are based.

6.5 Recommendations for future research

As Max Weber wrote: "Every scientific fulfilment raises new questions; It asks to be surpassed and outdated". This thesis therefore not only presents the results and conclusions from our studies, it also raises new questions regarding the relationship between task characteristics and task-related learning outcomes. We differentiate between 1) methodological recommendations to investigate the relationship between task characteristics and task-related learning by means of high quality research designs, and 2) content-related recommendations to investigate remaining gaps in our knowledge about task-related learning.

Methodological recommendations

As mentioned in §6.3, a limitation of this thesis is the limited external validity of our two experimental studies. Furthermore, from the literature review in Chapter 3 we learned that studies in this area are either cross-sectional field studies or experimental lab studies. A key recommendation for future studies about task-related learning is therefore to apply high quality designs in a naturalistic setting that allow firm conclusions about the causality of task-related learning. To support causality, four conditions have to be met (Taris & Kompier, 2003): 1) The presumed cause (the learning antecedents) should precede the presumed (learning) consequence in time, 2) the focal variables should be statistically associated, 3) the presumed causal relationship should be theoretically plausible and 4) possible rival hypotheses should be excluded.

Cross-sectional designs can only satisfy the second and third condition. Experimental lab studies on the other hand may fulfil all conditions, but this may happen at the cost of external validity. We thus recommend that future topical studies increasingly apply designs that score favourably on the aforementioned causation-conditions: full panel longitudinal studies, quasi-experimental studies or intervention studies that manipulate task-related learning experimentally in a naturalistic setting.

High quality longitudinal studies. High quality longitudinal studies apply a multi-wave, full panel design in which all variables (e.g., task characteristics, motivation, exploration behaviour, task performance, perceived learning) are measured at all time points. This approach enables an examination of causal and mediational processes (Taris & Kompier, 2006). Based on earlier studies by De Lange and colleagues (2005), we believe that time lags of a half or one year can be considered appropriate for the investigation of the relationship between task characteristics and task-related learning. In order to get more insight into possible curvilinear effects of task characteristics, we recommend comparing three groups (for example employees with low, moderate and high levels of autonomy) in a three wave study. For the groups reporting a stable (low, moderate or high) level of autonomy over all waves, it would be interesting to investigate to what extent these groups show different patterns across-time in learning processes (such as motivation and exploration behaviour) and learning outcomes (such as (increased) task performance), and to investigate whether learning processes mediate the relationship between task characteristics and learning outcomes. The study of effects of changing autonomy trajectories may also shed more light on causal mediational processes.

Quasi experimental field studies. In a quasi-experimental field study, it would be interesting to examine how task-related learning occurs among newcomers. For newcomers, especially trainees or recent graduates, most of the job related tasks will be new. It would be interesting to investigate variables such as motivation to learn and available job relevant knowledge and skills before newcomers start their job, as well as in a second and third wave in order to measure task-related learning outcomes. The appropriate length of these waves will depend on the particular job. When the job requires simple tasks that are easy to learn, this investigation could be done by day-to-day studies, an intensive experience sampling through diary studies (Van Hooff, Geurts, Taris & Kompier, 2006).

Intervention studies. Intervention studies constitute another appropriate design to investigate the influence of task characteristics on task-related learning. Potentially, an intervention study is a strong design to examine causation (Kristensen, 2000). When a relationship between A (e.g., task autonomy) and B (e.g., motivation to learn, task-related learning outcomes) is hypothesized, an imposed change in A should result in a corresponding change in B. Interventions that change task characteristics for the better thus might lead to better learning outcomes and the study of such interventions may contribute to causal evidence.

Content-related recommendations

We believe that future studies could pay more attention to the 'why and how' questions, i.e., the question of the learning processes. We also recommend that future studies pay more attention to the role of individual characteristics.

Learning processes as underlying mechanisms. This thesis provided a possible answer to the question how increasing job demands (i.e., goal difficulty) may lead to increased levels of learning. This relationship may exist because increasing job demands will motivate a learner to set increasing personal goals that enlarge the gap between the desired and actual state (Chapter 3 and Figure 6.6). From Figure 6.6 we may also conclude that still much is to be learned about the relationships between (combinations of) other task characteristics and other learning processes, e.g., the construction of a more adequate mental model (cf. Chapter 2).

The role of individual differences. In the black box that relates task characteristics to task-related learning outcomes individual differences may also play an important (moderating) role. For instance, personality traits such as action styles and goal orientation may affect the relationship between task characteristics and task-related learning outcomes (cf. Frese & Zapf, 1994; Taris & Kompier, 2005; Taris & Wielenga-Meijer, 2010). It is plausible that action-oriented learners are better able to take advantage of any degree of autonomy they have in realizing better learning outcomes than state-oriented learners (cf. Kuhl & Beckmann, 1994). Therefore, we recommend that future studies will investigate the role of such individual differences in the relationship between task characteristics and learning. One way to proceed in this direction is through survey studies that assess task characteristics, individual traits, learning processes and task-related learning outcomes longitudinally, as mentioned above.

Also more transient differences in coping capacities (e.g., due to fatigue) may play a role in the relationship between autonomy and learning. For example, Van der Linden, Frese and Sonnentag (2003) found that mental fatigue decreased learners' exploration and learning behaviour when they had to learn a complex computer task. Also the relationship between autonomy and task-related learning outcomes may be moderated by factors such as fatigue. We thus recommend that future research put more emphasis on more stable as well as transient individual characteristics.

6.6. Practical implications

We believe that the research reported in this thesis has practical implications, especially with respect to maximizing employee learning. Our two main practical messages are: 1) Autonomy may affect task-related learning outcomes curvilinearly and not only linearly, 2) Task characteristics may influence learning because of their impact on motivational, meta-cognitive and behavioural processes.

Curvilinear effect of autonomy on task-related learning outcomes
High levels of autonomy foster employee's motivation, exploration and task-related learning outcomes (Chapter 2 - 5). This implies that jobs should provide sufficient latitude to incumbents to allow them to explore new ways of carrying out their tasks. Autonomy provides employees with a sense of ownership and responsibility. This also implies that employees have opportunities to explore and to make errors. However, they must also get sufficient guidance during their task. An overdose of autonomy should be avoided in order to provide enough structure to the employees. In principle, autonomy is beneficial, but having 'too much of a good thing' (Langfred, 2004) leads to suboptimal outcomes, in that learners will need higher levels of exploration behaviour and more time to reach outcomes that could have been realized equally well with lower levels of autonomy. For example, when newcomers in a job must become familiar with their tasks, the absence of autonomy may well result in low motivation, little exploration behaviour and low levels of learning, resulting in low task performance (Feij, 1998; Taris & Kompier, 2005). When *too much* autonomy (and too little guidance) is provided, new workers may, in time, possibly reach similar levels of performance as those having adequate levels of autonomy. However, they may well need more time and effort to reach this level of performance. Therefore, employers should provide enough (rather than too much) autonomy to workers by providing clear guidance with respect to the job content as well as room for exploration in a supporting context, in order to stimulate learning in the most efficient way.

Learning processing that account for the relationship between task characteristics and task-related learning outcomes
Based on this thesis, we assume that motivational, meta-cognitive processes (i.e., setting personal goals) and behavioural processes (exploration) are related to the learning outcomes. It may be worthwhile for supervisors to regularly check upon their subordinates' task characteristics (e.g., demands, workload, autonomy, feedback), motivation, work goals and exploration behaviour as well as learning outcomes. It seems desirable that these issues are addressed regularly during work consultation and yearly performance evaluation interviews. In this way, employees have the freedom to monitor the learning potential context of their work and their supervisors may detect deficits at an early stage, meaning that serious problems in these respects can be dealt with timely and effectively.

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6

Summary

Introduction

The work environment is changing rapidly these days because of technological developments, globalized competition, reorganizations and organizational development. In order to deal with these changes, it is essential that employees continuously acquire new skills and knowledge and develop their existing skills and knowledge. A common and frequently used method to improve employees' skills and knowledge is to offer them training and schooling, either on or off-the-job. This can be described as *formal learning*, because the training and schooling are specifically devised to increase employees' skills and knowledge. However, learning may also occur while simply doing the job or conducting one's task. As these ways of learning are not specifically devised for learning, it is customary to refer to this type of learning as *informal learning*. As yet, only a paucity of studies has investigated this latter form of learning, which is remarkable as informal learning may well be one of the most important ways to acquire new work-related knowledge and skills.

An important question is whether task characteristics influence task-related learning. This question also raises the questions why and how this association may exist. Insight into these questions may provide guidelines for job (re)design, in such a way that the characteristics of the job may improve and facilitate (informal) learning while conducting job-relevant tasks. This thesis presents four studies that aim to increase our understanding of task-related learning. In these studies we address the questions *when* task-related learning may occur (which task characteristics may influence task-related learning) and which learning processes may account for this relation (providing insight into the questions *why* and *how* this relationship may exist). To address these questions, this thesis presents an extensive theoretical framework, including a theoretical review and a review of empirical evidence regarding the relationship between task characteristics, learning processes and task-related learning outcomes (*Research issue 1* and *2*). Subsequently, this thesis focuses on the questions when, why and how the relationship between autonomy and task-related learning outcomes may exist (*Research issue 3*). Specifically, this thesis examines the following research issues:

1. Which task characteristics and which learning processes are *theoretically* assumed to promote task-related learning outcomes?
2. Does *empirical evidence* support the theoretically assumed relationships between task characteristics, learning processes and task-related learning outcomes?
3. When, why and how can the relationship between autonomy and task-

related learning outcomes exist?

Results of the studies

Research issue 1 (Chapter 2): Which task characteristics and which learning processes are theoretically assumed to promote task-related learning outcomes?

Based on a review of five major theories, we propose that task-related learning outcomes can be increased when a task provides high (but not overwhelming) job demands, enough variety, autonomy and meaningful feedback. A reason *why* this relationship could exist is that these task characteristics may increase motivation. Three ways *how* these task characteristics may influence task-related learning outcomes is that they may stimulate cognitive processes (i.e., the construction of a mental model) and meta-cognitive processes (i.e., setting (high) personal goals) as well as behavioural processes (i.e., exploration behaviour).

Research issue 2 (Chapter 3): Does empirical evidence support the theoretically assumed relationships between task characteristics, learning processes and task-related learning outcomes?

Chapter 3 builds on Chapter 2 by investigating whether existing empirical evidence supports the theoretically assumed relationships between task characteristics, learning processes and task-related learning outcomes. In a quantitative literature review including 85 studies, we found evidence for the hypotheses that learning outcomes are positively associated with the task characteristics job demands, autonomy and feedback frequency as well as with each of the four aforementioned learning processes. Furthermore, this chapter shows strong evidence for positive relationships between the task characteristics job demands, autonomy, and feedback sign (positive feedback) on the one hand and motivation on the other hand. Strong evidence is also found for the relationship between job demands and personal goal setting. The most remarkable finding, however, considers the paucity of studies regarding the relationship between task characteristics and learning outcomes that included one of the learning processes as a mediator. The only conclusion we can draw is that moderately strong evidence is found for the assumption that high job demands improve task-related learning outcomes because these high job demands stimulate people to set high personal goals.

Research issue 3 (Chapter 4 and 5): When, why and how can the relationship between autonomy and task-related learning outcomes exist?

Based on two experimental studies in which we manipulated three levels of autonomy in between subject designs, we aimed to enhance our understanding of the relationship between autonomy and task-related learning outcomes. Chapter 4 shows that motivation (explaining why) and exploration behaviour (describing how) jointly account for the relationship between autonomy and task-related learning outcomes. Chapters 4 and 5 both demonstrate that this relationship is not linear. Moderate levels of autonomy lead to similar levels of task-related learning outcomes when compared to full levels of autonomy. However, participants need more time to reach this level of task-related learning outcomes when having full autonomy, than when they possessed moderate levels of autonomy. The findings in Chapter 5, in which the availability of cognitive resources was manipulated as well, suggest that full levels of autonomy require more information processing capacities than moderate levels of autonomy. This finding may explain why 'too much' of autonomy may have adverse learning effects.

Discussion

Chapter 6 describes the theoretical implications, limitations, assets, recommendations for future studies and practical implications of this thesis.

Theoretical implications

Firstly, this thesis presents a heuristic model (Chapter 2) that provides insight into the black box of learning processes (explaining why and how) that account for the relationship between task characteristics and task-related learning outcomes. This model may serve as a foundation for future studies concerning the relationship between task characteristics, learning processes and task-related learning outcomes. A second theoretical implication involves the curvilinear relationship between autonomy and learning outcomes. Contrary to most theoretical assumptions, this thesis shows that increasing levels of autonomy do not necessarily result in linearly increasing levels of task-related learning outcomes. More and above, this thesis indicates that having too much autonomy may be disadvantageous for learning outcomes. In future studies it is important to take into consideration that the relationship between autonomy and outcomes may be curvilinear.

Limitations

The most important limitation of this thesis involves the conceptualization of the variables and more specifically, the validity of the experimental studies. Our theoretical and empirical reviews (Chapter 2 and 3) are based on broad conceptualizations of the key concepts. The differences among these measures might endanger their validity, since these measures could represent different underlying constructs and processes. Related to this validity issue, it is important to note that we manipulated two aspects of autonomy in our experimental studies (Chapter 4 and 5): the freedom to explore and the availability of instructions. Therefore, we do not have insight into the separate effects of these two aspects on task-related learning outcomes.

Assets

Notwithstanding its limitations, this thesis contributes to current knowledge on the relationship between task characteristics and task-related learning outcomes. Firstly, this thesis presents a well-balanced research program into the associations among task characteristics and task-related learning. It starts with a review, a comparison and an integration of five major theories, resulting in a heuristic model. Subsequently, this thesis presents a review of empirical studies, including a large number of studies covering a 40-year time span and a variety of scientific disciplines. A second asset is that this thesis also presents a focused and experimental investigation of one of the assumed relationships from the heuristic model.

Recommendations for future research

This thesis provides several recommendations for future research, including methodological and content-related recommendations.

Chapter 3 shows that research that considers the relationship between task characteristics and task-related learning usually employs either cross-sectional field designs or experimental laboratory designs. Studies employing the former method cannot draw conclusions regarding the causality of the investigated relations, while external validity may be threatened in studies employing the latter approach. We therefore recommend conducting high-quality field studies such as longitudinal surveys, quasi-experimental field studies and intervention studies to investigate the relationship between task characteristics and task-related learning.

Furthermore, we assume that the learning processes formulated in Chapter 2 account for the relationship between task characteristics and task-related learning outcomes. However, the role of these potential mediating variables has been under investigated (Chapter 3). Therefore, the first content-related recommendation involves the advice to continue research investigating the role of psychological processes, accounting for the relationship between task characteristics and task-related learning outcomes. Additionally, we would recommend to investigate to what extent individual differences or transient factors (such as fatigue) may influence the relationship between task characteristics and task-related learning outcomes. It should be possible to obtain a better understanding of the factors that affect the strength of the relation between task characteristics and task-related learning outcomes.

Practical implications

This thesis has at least two practical implications. Firstly, it shows that the effect of autonomy on task-related learning outcomes is curvilinear rather than linear. This finding may entail practical implications, for example, during the socialisation phase of a new job. This thesis proposes that providing too much autonomy (by providing freedom to explore without any guidance) will decrease efficiency while learning a new task. This suggests that newcomers should ideally receive both the freedom to explore how to accomplish their tasks *as well as* the necessary guidance to learn how to conduct these tasks.

Secondly, it is important to realise that the relationship between autonomy and task-related learning outcomes may exist because autonomy increases motivation and exploration behaviour. This suggests that when learners are not motivated to learn or explore while conducting a new task, task-related learning outcomes (such as improved task performance) will be close to zero. It may therefore be worthwhile for supervisors to regularly check up on their subordinates' task characteristics (e.g., demands, workload, autonomy, feedback), motivation, work goals and exploration behaviour as well as their learning outcomes. It would seem beneficial to address these issues regularly during work consultation and yearly performance evaluation interviews.

Samenvatting

Summary in Dutch

Inleiding

De werkomgeving van vandaag de dag verandert in hoog tempo, mede door snelle technologische ontwikkelingen, reorganisaties, wereldwijde competitie, enzovoort. Om binnen deze dynamische werkomgeving het hoofd boven water te houden is het voor werkenden essentieel om continu nieuwe vaardigheden te leren, nieuwe kennis op te doen en om reeds opgedane vaardigheden en kennis te onderhouden en verder te ontwikkelen. Met andere woorden: De huidige dynamische werkomgeving eist van haar werknemers dat ze continu blijven *leren* tijdens het uitvoeren van hun werkzaamheden. Een gebruikelijke, veelvuldig onderzochte manier om werknemers nieuwe kennis en vaardigheden aan te leren, is om hen deel te laten nemen aan cursussen en trainingen. Dit wordt wel *formeel* leren genoemd, omdat dergelijke trainingen speciaal ontwikkeld zijn om de werknemers kennis te laten opdoen en hun vaardigheden (verder) te laten ontwikkelen. Daarnaast is het mogelijk dat werknemers leren tijdens hun werk door simpelweg hun taken uit te voeren, zonder dat hier een specifieke training aan vooraf gaat. Deze vorm van 'leren door te doen' wordt *informeel* leren genoemd. Tot op heden is deze manier van leren nog nauwelijks onderzocht in de arbeidscontext. Dit is opmerkelijk, omdat werknemers aangeven dat leren door te doen in de praktijk één van de belangrijkste manieren is om nieuwe werkgerelateerde kennis en vaardigheden op te doen.

Een belangrijke vraag is of en in hoeverre dit informele leren kan worden beïnvloed door kenmerken van de taak zelf. Twee vragen die hieruit voortkomen zijn waarom en hoe deze relatie kan ontstaan. Wanneer we inzicht hebben in de antwoorden op deze vragen zou het werk en de taken die binnen dit werk worden uitgevoerd zodanig kunnen worden aangepast, dat het uitvoeren van de taak het leren stimuleert of vergemakkelijkt. In dit proefschrift worden vier studies beschreven die tot doel hebben om beter begrip te krijgen van de factoren die het taakgerelateerde, informele leren bevorderen. Deze studies hebben tot doel om inzicht te krijgen in de vragen *wanneer* (in geval van welke taakkenmerken) taakgerelateerd leren kan plaatsvinden en via welke psychologische processen (welke kunnen verklaren *waarom* en *hoe*) deze relatie verloopt. Om antwoord te krijgen op deze vragen, zijn we gestart met het leggen van een breed theoretisch fundament dat is gebaseerd op een theoretische review en een review van de empirische evidentie betreffende de relatie tussen taakkenmerken, psychologische leerprocessen en taakgerelateerde leeruitkomsten (*Onderzoeksissue 1* en *2*). Vervolgens hebben we ons geconcentreerd op de 'wanneer, waarom en hoe'-vragen betreffende de relatie tussen autonomie en leeruitkomsten (*Onderzoeksissue 3*). De onderzoeksissues die ten grondslag lagen aan dit proefschrift zijn:

1. Welke taakkenmerken en welke leerprocessen zouden *theoretisch* gezien taakgerelateerde leeruitkomsten verhogen?
2. Worden deze theoretisch veronderstelde relaties tussen taakkenmerken, leerprocessen en taakgerelateerde leeruitkomsten *empirisch* ondersteund?
3. Wanneer, waarom en hoe kan de relatie tussen autonomie en taakgerelateerde leeruitkomsten bestaan?

Resultaten van de studies

Onderzoeksissue 1 (Hoofdstuk 2): Welke taakkenmerken en welke leerprocessen zouden theoretisch gezien taakgerelateerde leeruitkomsten verhogen?

Hoofdstuk 2 beschrijft een review van vijf invloedrijke theorieën welke worden geïntegreerd tot een heuristisch model. Op basis hiervan veronderstellen wij dat taakgerelateerde leeruitkomsten positief zouden worden beïnvloed *wanneer* de taak hoge (maar geen overweldigende) taakeisen, genoeg variatie, voldoende autonomie en betekenisvolle feedback biedt. Een reden *waarom* de relatie tussen deze taakkenmerken en taakgerelateerde leeruitkomsten kan bestaan is dat deze vier taakkenmerken de motivatie van de werknemer kunnen verhogen, waardoor de werknemer bereid is om meer moeite te doen de taak goed uit te voeren. Daarnaast onderscheiden wij drie manieren *hoe* deze taakkenmerken het leren kunnen beïnvloeden. Ten eerste stimuleren deze vier taakkenmerken cognitieve processen, waaronder de constructie van een correct mentaal model van de taak. Dit houdt in dat de werknemer de taak beter begrijpt. Ten tweede hebben deze taakkenmerken een positieve invloed op meta-cognitieve processen (denk hierbij aan zelfregulatie), zoals het stellen van hoge persoonlijke doelen. Ten derde stimuleren deze vier taakkenmerken gedragsmatige processen zoals exploratiegedrag. Dit wil zeggen dat de werknemer dankzij deze taakkenmerken gestimuleerd kan worden om de taak op verschillende manieren uit te voeren, om daarbij te achterhalen (ofwel te *leren*) hoe de taak efficiënter of prettiger uitgevoerd kan worden.

Onderzoeksissue 2 (Hoofdstuk 3): Worden deze theoretisch veronderstelde relaties tussen taakkenmerken, leerprocessen en taakgerelateerde leeruitkomsten ondersteund met empirische evidentie?

In Hoofdstuk 3 bouwen we voort op de bevindingen van Hoofdstuk 2 door te onderzoeken in hoeverre er empirische evidentie is voor de veronderstelde relaties tussen taakkenmerken, leerprocessen en taakgerelateerde leeruitkomsten. Middels een kwantitatieve literatuurstudie met 85 empirische studies vinden we evidentie voor de hypotheses dat taakgerelateerde leeruitkomsten positief samenhangen met de taakkenmerken taakeisen, autonomie en de hoeveelheid feedback, alsook met al de vier genoemde leerprocessen. Deze review laat tevens sterke evidentie zien voor de veronderstelling dat taakeisen, autonomie en positieve feedback (oftewel feedback sign) samenhangen met verhoogde motivatie. Daarnaast vinden we sterke evidentie voor een positieve relatie tussen taakeisen en het stellen van (hoge) persoonlijke doelen. De meest opvallende bevinding van deze review echter betreft het relatief lage aantal studies dat gedaan is naar de relatie tussen taakkenmerken en leeruitkomsten, waarbij één van de genoemde leerprocessen als mediator is opgenomen. Op basis van onze studie uit Hoofdstuk 3 kunnen we slechts over 1 mogelijke relatie conclusies trekken, namelijk de relatie tussen taakeisen, persoonlijke doelen en leeruitkomsten: Wij vinden redelijk sterke evidentie voor de veronderstelling dat hoge taakeisen leiden tot betere leeruitkomsten, omdat deze hoge taakeisen ertoe leiden dat mensen ook hogere persoonlijke doelen zullen stellen.

Onderzoeksissue 3 (Hoofdstuk 4 en 5): Wanneer, waarom en hoe kan de relatie tussen taak autonomie en taakgerelateerde leeruitkomsten bestaan?
Aan de hand van twee experimentele studies waarin drie niveaus van autonomie zijn gemanipuleerd in een tussen-proefpersonen design, hebben we meer inzicht willen krijgen in de relatie tussen taak autonomie en taakgerelateerde leeruitkomsten. De studie in Hoofdstuk 4 laat zien dat een combinatie van motivatie (als antwoord op de 'waarom' vraag) en exploratiegedrag (als antwoord op de 'hoe' vraag) ten grondslag ligt aan de relatie tussen autonomie en leeruitkomsten. Verder laten de experimenten in de Hoofdstukken 4 en 5 zien dat de relatie tussen autonomie en leeruitkomsten niet linear is. Een gemiddeld niveau van autonomie blijkt tot dezelfde leeruitkomsten te leiden als volledige autonomie. Echter, om ditzelfde leerresultaat te bereiken is bij volledige autonomie meer tijd nodig, wat als nadelig kan worden gezien. De bevindingen in Hoofdstuk 5, waarin ook de beschikbaarheid van informatieverwerkingsprocessen werd gemanipuleerd, suggereren dat volledige autonomie meer cognitieve informatieverwerking vereist dan een gemiddeld niveau van autonomie. Deze bevinding kan verklaren waarom 'te veel' autonomie negatieve effecten op leren kan hebben.

Discussie

Hoofdstuk 6 beschrijft de theoretische implicaties, beperkingen, sterke punten, aanbevelingen en praktische implicaties van dit proefschrift.

Theoretische implicaties

Ten eerste presenteert dit proefschrift een heuristisch model (Hoofdstuk 2) dat inzicht geeft in de 'black box' van leerprocessen die een rol kunnen spelen in de relatie tussen taakkenmerken en taakgerelateerde leeruitkomsten. Dit model kan in de toekomst dienen als basis om de relatie tussen taakkenmerken en leeruitkomsten verder uit te diepen en nog beter te begrijpen.

Een tweede theoretische implicatie betreft de niet-lineaire relatie tussen autonomie en taakgerelateerde leeruitkomsten. In tegenstelling tot wat de meeste theorieën veronderstellen, blijkt een toenemende hoeveelheid autonomie niet te leiden tot een evenredige toename in taakgerelateerde leeruitkomsten. Een teveel aan autonomie blijkt zelfs negatieve consequenties te kunnen hebben. Zowel voor de praktijk als voor toekomstig onderzoek is het van belang dat rekening gehouden wordt met dit niet-lineaire verband tussen autonomie en leeruitkomsten.

Beperkingen

De belangrijkste beperking van dit proefschrift betreft de conceptualisatie van de variabelen en, meer specifiek, de validiteit van de experimentele studies. Onze theoretische en empirische reviews (Hoofdstuk 2 en 3) zijn gebaseerd op brede conceptualisaties van de belangrijkste begrippen. Dit kan betekenen dat deze begrippen op meerdere manieren geïnterpreteerd of gemeten kunnen worden, wat een bedreiging kan zijn voor de validiteit van deze begrippen. Gerelateerd aan deze validiteitskwestie, melden we dat in onze autonomie manipulatie (Hoofdstuk 4 en 5) twee aspecten van autonomie zijn gemanipuleerd: 1) de vrijheid in exploratie en 2) het al dan niet krijgen van instructies. Hierdoor hebben we geen inzicht gekregen in de eventueel afzonderlijke effecten van deze twee kenmerken van autonomie op taakgerelateerd leren.

Sterke punten

Dit proefschrift heeft echter ook een aantal sterke punten. Ten eerste presenteert dit proefschrift een goed gebalanceerd onderzoeksprogramma naar de relatie tussen taakkenmerken en taakgerelateerde leeruitkomsten. Het begint met een studie, vergelijking en integratie van vijf invloedrijke theorieën, resulterend in een heuristisch model. Om dit model te toetsen, presenteert dit proefschrift een review van een groot aantal empirische studies, welke een tijdsspanne van 40 jaar, en een diversiteit van wetenschappelijke disciplines omvat. Een tweede sterk punt is dat in dit proefschrift niet alleen breed georiënteerd is op de relatie tussen taakkenmerken en taakgerelateerde leeruitkomsten, maar dat hierin ook is geconcentreerd op één van de relaties uit het heuristisch model door middel van experimentele studies.

Aanbevelingen voor vervolgonderzoek

In dit proefschrift doen we een aantal aanbevelingen voor vervolgonderzoek, welke we kunnen onderverdelen in methodologische en inhoudelijke aanbevelingen.

Hoofdstuk 3 laat zien dat onderzoek naar de relatie tussen taakkenmerken en taakgerelateerd leren ofwel in het veld plaatsvindt met behulp van cross-sectionele studies, ofwel in een laboratorium met behulp van experimentele studies. In het eerste geval kunnen geen harde uitspraken worden gedaan over causaliteit, terwijl het tweede geval ongunstig is voor de externe validiteit. Wij bevelen daarom aan dat in de toekomst meer longitudinale veldstudies gedaan worden om de relatie tussen taakkenmerken en taakgerelateerd leren nader te onderzoeken. Daarnaast doen wij de aanbeveling om quasi-experimentele veldstudies of interventiestudies te verrichten, om zo de externe validiteit te waarborgen en tevens uitspraken over de causaliteit te kunnen doen.

De eerste inhoudelijke aanbeveling is om verder te gaan met het onderzoek naar de mogelijke psychologische processen die ten grondslag liggen aan de relatie tussen taakkenmerken en taakgerelateerd leren. Naar aanleiding van dit proefschrift hebben we redenen om aan te nemen dat de geformuleerde leerprocessen een belangrijke rol spelen in de relatie tussen taakkenmerken en taakgerelateerd leren. Echter, in voorgaand onderzoek zijn deze processen nog onderbelicht.

Daarnaast bevelen wij aan om te onderzoeken in hoeverre individuele verschillen of tijdelijke factoren zoals vermoeidheid invloed hebben op de relatie tussen taakkenmerken en taakgerelateerd leren, om zodoende meer inzicht te krijgen in factoren die de sterkte van de relatie tussen taakkenmerken en taakgerelateerde leeruitkomsten beïnvloeden.

Praktische implicaties

Dit proefschrift doet twee praktische aanbevelingen. Ten eerste leert dit proefschrift dat het effect van autonomie op leren niet (altijd) linear is. Deze bevinding kan implicaties hebben voor onder andere de socialisatie fase binnen een bedrijf. Onze studies laten zien dat leren het meest efficiënt en effectief gebeurt wanneer men niet alleen vrijheid heeft om te exploreren, maar ook sturing krijgt tijdens het leren van een nieuwe taak. Nieuwe medewerkers zouden daarom idealiter vrijheid *en* sturing krijgen (en dus niet teveel aan autonomie, waarin werknemers als het ware aan hun lot worden overgelaten).

Ten tweede is het van belang te realiseren dat de relatie tussen autonomie en taakgerelateerd leren veroorzaakt kan worden door motivatie en exploratiegedrag. Indien men niet gemotiveerd is en niet exploreert tijdens het uitvoeren van een nieuwe taak, is te verwachten dat leeruitkomsten, zoals een verbeterde taakprestatie, nihil zullen zijn. Daarom is het raadzaam voor werkgevers om niet alleen aandacht te besteden aan prestatie indicatoren, maar ook aan de taakkenmerken (bijvoorbeeld taakeisen, autonomie, feedback) waar de werknemer aan wordt blootgesteld, en aan factoren zoals motivatie, persoonlijke doelen en exploratiegedrag. Het kan gunstig zijn om deze issues regelmatig tijdens overleg- en functioneringsgesprekken te bespreken.

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Etty
Duiven, 6 mei, 2010

8 Almachtige God, wij danken U voor Uw weldaden. U, die leeft en heerst in de eeuwen der eeuwen.

About the author

Etty Wielenga-Meijer was born on January 1977 in Bree (Belgium). In 1996 she finished her grammar school at the 'Simon Vestdijk' in Harlingen (the Netherlands). From 1996 until 1998 she studied 'Creative Therapy', but she decided to switch to study psychology. In 2003 Etty graduated (with honours) as a work and organizational psychologist at the university of Groningen. In 2004, she started her PhD project at the department of Work and Organizational Psychology within the Behavioural Science Institute of the Radboud University Nijmegen. Since September 2009, she works as a lecturer at the HAN University of applied science, in Arnhem and Nijmegen.

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